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QUARTERLY

OF THE

National Fire Protection Association

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60 BATTERYMARCH STREET, BOSTON, MASS.

Application Blank for Associate Membership

Associate Membership is open to any Society, Firm, Corporation or Individual interested in the protection of life and property against loss by fire. Persons in every walk of life are members.

National Fire Protection Association

INTERNATIONAL

Organized 1896

EXECUTIVE OFFICE: 60 BATTERYMARCH STREET, BOSTON, MASSACHUSETTS

All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member.

We furnish free to members the Regulations issued by the National Board of Fire Underwriters, and the lists of devices and materials inspected by Underwriters' Laboratories, Inc.

The Association is the clearing house for all the authoritative information on Fire Protection and Prevention and members are privileged to submit to it their individual problems for solution.

PUBLICATIONS

Quarterly Magazine of the Association. A chronicle of the Association's activities, with valuable contributions of articles on fire prevention and protection and special hazards, and compilations of fire statistics on various classes of property.

News Letter. A special monthly bulletin of timely information on fire prevention and kindred subjects.

Proceedings of Annual Meeting. Containing stenographic report of transactions of the Association and the discussions incident to the adoption of its standards.

Special reports, bulletins, etc., issued frequently during the year.

Year-book and directory. Complete list of members with addresses.

Index to all subjects covered in the Printed Records.

NATIONAL FIRE PROTECTION ASSOCIATION,
60 Batterymarch Street, Boston, Mass.

Please enroll me (or us) as an associate member, and forward the publications to which members elected this month are entitled. I transmit herewith $10.00 as my annual membership dues, which includes a year's subscription to the "Quarterly" of the National Fire Protection Association.

Name.....

Business Connection.....

Street and Number.....

City and State.....

Membership year begins with date of election.

$10 per year dues is the total expense.

No initiation fee, no further assessments.

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International.

The Los Angeles Fire Department is shown using aerial ladder equipment and monitor nozzles to extinguish a fire which swept the old Gray Building in the downtown district on November 6, 1939, with a loss of $113,000. The fire spread so rapidly through the combustible construction housing various tenant shops, that some of the occupants had to be rescued by firemen. Interior partitions which did not extend to the ceiling offered great resistance to effective direction of hose streams and almost none to the fire. One fireman was killed by the collapse of a weakened floor while directing a hose stream inside of the building. Such a fire shows that even the most powerful municipal fire equipment cannot always overcome the handicap of failure to provide adequate automatic protection in such fire-trap occupancies.

The Quarterly

Vol. 33 January, 1940 No. 3

What Youth Sees. Coming out of a fire prevention meeting recently a well-posted, somewhat cynical engineer observed of the meeting's young speaker that he had "voiced with all the enthusiasm of original discovery opinions gleaned from the daily press." It drew a thoughtless laugh. But where did the daily press glean its opinions? Where did the engineer glean his? Is anybody born with fire prevention information?

Every generation must be taught to act upon the accumulated knowledge of the race. The enthusiasm that follows the discovery of useful facts is the vehicle that carries them on to continuous public service. How about our fire prevention literature? Does it sparkle every year with new and striking applications? It does not. It cannot. Only when invention or industry develops new and unknown fire hazards can it say about fire prevention anything except the well-known things accumulated experience has made vocal. It is current publication of old truths which are new to each generation that when first encountered stimulate youth by their novelty and arouse "the enthusiasm of original discovery" which makes them seem worth repeating. It is well for us not to yield too much to boredom when we hear youth crying out with authoritative utterance the things we've known for so long. Rudyard Kipling adequately expressed the truth in the Cockney phrase of his barrack room ballads:

"When 'Omer smote his bloomin' lyre
He'd 'eard men sing on land and sea
And what 'e thought 'e might require
He went and took, the same as me."

* * * * *

What Rome Saw. In the field of fire prevention there are really but three major ideas, viz.: to protect the source of fire; to prevent its lateral spread; to prevent its vertical spread. Every step in fire protection engineering is merely a refinement of those three objectives. Building codes, exit codes, water services, city planning, all the modern ramifications of these ideas are fascinating to conjure with, but there is nothing fundamentally new about them; the so-called ancients recognized them as well as we do. Tacitus in his "annals" says in Nero's time, along about A.D. 54 to 68, that

Rome was built up, not as it had been after its burning by the Gauls, without any regularity, or in any fashion, but with rows of streets "according to measurements," with open spaces and the addition of colonnades as a protection to the frontage of the blocks of tenements. The buildings, to a certain height, were to be constructed solidly — and without wooden beams — of stone from Gabii or Alba, as that material is impervious to fire. And to provide that the water, which individuals had illegally used, might flow in greater abundance in several places for the public use everyone was to have an open court as a means of stopping a fire. Every building was to be enclosed by its own wall, not by one common to others. Aurelius Victor, in his "Roman Emperors," speaking of Trajan (98 to 117 A.D.) says he passed a law which limited the height of houses to sixty feet "that they might be in less danger of falling, and in case they should fall, they might be repaired at less expense." There is something in these specifications of the emperors that makes one think of a modern building code.

* * * * *

1940 Projects. There are those who seem to believe that the strength of an organization lies principally in incessant activity, in embarking on anything so long as it keeps things moving. It may have advertising value of some sort to maintain an open mind and no particular program; but it isn't easy under such a policy to reckon up gains for the year. The N.F.P.A. activities are diversified, but like streams converging to the sea they all make for a single end. And like streams they also have different rates of flow. It was George Santayana who said the difficult can be done immediately, but that the impossible takes a little longer. The prospective revision of our engineering handbook to be issued in 1940 might be labeled difficult. It is no simple task, but it has been done successfully before; and with the infinite painstaking it demands can be done again. There is no element of uncertainty in it — not even the most skeptical would call it impossible.

The continuing project of our publication, VOLUNTEER FIREMEN, cannot be so easily disposed of. It was undertaken at the lowest period of the last business depression, no matter how financially impossible it seemed, simply because it had to be. It could not wait. The fire loss peak had shifted from city industries to rural and small town properties, and something had to be done about it. Most likely 1940 will not yet see VOLUNTEER FIREMEN out of the red, but it has already demonstrated its usefulness and there is no other publication anywhere in its field that can do its work. It is an imperative project even though its improvement and further development should temporarily entail Association economies in other directions. But that it shall eventually be an asset to the Association in the economic as well as in the educational sense we thoroughly believe. In the phrase of Santayana it is an impossible task that will simply take a little longer.

The N.F.P.A. Committees. In 1940, as in previous years, the fundamental basis of all the Association's activities will lie in the work of our fifty committees with an aggregate membership of a thousand members and representatives who are freely giving of their time, knowledge and experience for the Association's work of reducing loss of life and property by fire. All the educational and promotional activities of the N.F.P.A. rest upon the sound basis of the factual knowledge and best engineering opinion developed by our committees with the assistance of many coöperating organizations.

Those who do not participate in the committee work and have no contact with it except by attendance at N.F.P.A. annual meetings or reading of final reports can have little conception of its extent and importance. The Electrical Committee, for example, last month held a meeting lasting for five days, with morning, afternoon and evening sessions at which matters of far-reaching importance were considered, and detailed proposals for changes in the National Electrical Code were discussed and acted upon. Committee members, alternates and technical advisors in attendance numbered over one hundred. This meeting was the culmination of activities extending over the past year, with numerous preliminary meetings, discussion of proposed changes in meetings of coöperating organizations, preprinting and general circulation of material to be acted upon, and voluminous correspondence. It was all for the purpose of producing a 1940 edition of the National Electrical Code, recognizing new developments, affording all interests concerned an opportunity to present their views, and maintaining the code as the national recognized consensus of good practice in electrical installations for reasonable safety to life and property without unnecessary interference with continuing extension of the use of electricity, all in the public interest.

While the Electrical Committee is the Association's largest and most influential committee, the work of all the other committees is conducted on a similar high plane, and in their respective fields various other N.F.P.A. committees are equally important. A number of other committees, which because of lack of space cannot be individually mentioned here, are now hard at work, and will have reports of fundamental importance to present to the 1940 annual meeting of the Association.

* * * * *

Careful Smokers. From time to time the N.F.P.A. Executive office is criticized for a negative approach to fire prevention. We are told that it is the wrong psychology to tell people what they should not do, and to continually emphasize the death and destruction resulting from carelessness. We are told that we should emphasize carefulness, and say nothing about the careless and ignorant practices that are responsible for fires. We feel that the argument for fire prevention falls a little flat if no hint is given of what happens when fires are not prevented.

But let us try this approach to the cigarette smoker. Last year 140,000,000,000 cigarettes were sold in the United States. It is a remarkable tribute to the care and intelligence exercised by smokers in general that 139,999,910,000 of them were smoked safely. The average individual, according to the statistics, can smoke a pack a day for 213 years without causing a fire, and for 10,650 years or thereabouts without burning himself or anyone else to death. Isn't this impressive?

Furthermore, statistically speaking, the fire properties of the cigarette itself are remarkable. When thrown down, still burning, it will burn out, or go out, without causing damage probably 99% of the time. It is perfectly safe when it lands on a metal or other non-combustible surface, or on ordinary solid combustible material of such form and character that heat will be conducted away sufficiently to keep the temperature relatively low. Even in the case of finely divided combustible material, such as dry leaves, grass and forest litter, ignition cannot occur under average condition of humidity and wind velocity. Cases are on record where celluloid containers have been used as ash trays for some time without ignition. Professors have demonstrated in laboratory experiments that under carefully controlled conditions a lighted cigarette can be extinguished in gasoline.

So safe is the cigarette, in popular opinion, that a sizable percentage of the population habitually smokes while the automobile gas tank is being filled, discards burning cigarettes indiscriminately around buildings, throws them blithely from automobile windows while motoring through the woods, and nothing happens in at least 99% of the cases.

But the records still show 90,000 fires with $15,000,000 damage and hundreds of people burned to death annually in cigarette-started fires.

* * * * *

Growth of the Fire Prevention Bureau.

As of this month, the fire departments of 95 United States cities over 100,000 population and of many smaller ones operate organized fire prevention bureaus. In almost every city in the United States and Canada the fire department does some fire prevention inspection work.

Less than two decades ago there were only twenty of the larger cities which maintained some sort of fire prevention bureau organization. In general the fire department figured its duties began with the fire and ended when it was out. Such inspection as was done generally had the sole purpose of familiarizing the firemen with the interior of buildings in which they might have to fight fires and thus safeguarding their lives.

Nowadays it is pretty generally known that there is nothing a city can do with relatively small expense that will reduce fire hazards and losses more than the creation of a fire prevention bureau with a full-time staff having

proper authority to carry out its duties. The present survey shows that to date only St. Louis and Pittsburgh among the 42 cities of over 200,000 population have failed to take advantage of this fact.

For the most part, the fire prevention bureaus throughout the country are organized along lines set forth in the suggested ordinance establishing a bureau of fire prevention recommended by the N.F.P.A. However, there are still a considerable number of fire departments doing this work without the benefit of specific ordinances defining their powers and duties. These are compelled to operate entirely by persuasion. The experience of nearly all of the successful bureaus has demonstrated the importance of proper public relations and the desirability of tact in dealing with the public, but the bureaus all recognize the necessity of having the proper power through ordinances to take care of the exceptional cases where legal authority is needed to correct a condition.

The present extent of inspection activity in fire departments is proof in itself of the practicability and economic value of this part of the municipal fire protection scheme.

* * * * *

Chemical Weed Killers. Progress in the chemical industry is every year making more chemicals economically available for new uses. Various chemicals are now used for all sorts of common purposes by people who have no understanding of the properties and hazards of the material and are frequently ignorant of the necessary precautions for their safe storage and use. The N.F.P.A. Committee on Hazardous Chemicals and Explosives in coöperation with a similar committee of the American Chemical Society is meeting this situation by making available in simple form the essential information on common hazardous chemicals in the Table which was first adopted in 1929 and was published last year in its 4th edition. Doubtless, the information in this Table has been the means of preventing many fires and explosions.

The N.F.P.A. Executive Office receives many inquiries from fire chiefs, public officials and others concerning various chemicals listed in the Table. One such chemical which has received considerable recent attention is sodium chlorate, which is largely used as a weed killer. Dry weeds and grass around buildings and along highways or railroad rights of way present a well-known hazard, but it does not seem to be so well known that one of the common methods of destroying such unwanted vegetation itself may create a hazard.

A supply of sodium chlorate stored in a California city for use in destroying obnoxious vegetation along irrigation canals was last month the cause of a $15,000 fire. The material itself does not burn, but it is an oxidizing agent which is dangerous under fire conditions and explosive when in contact with combustible materials. The N.F.P.A. Table of Common Hazardous Chemicals

gives this information in condensed form for this and numerous other common chemicals. In the case of sodium chlorate, it includes the information that water is the best extinguishing agent, which information is of great importance to fire departments when confronted with a fire in some chemical with which they are not familiar and which may perhaps involve the danger of an explosion if the wrong extinguishing method is used.

A number of fires have been reported in connection with the use of sodium chlorate. During a hot dry period last summer a solution was being sprayed to kill vegetation along the right of way of an eastern railroad. A number of fires resulted when the solution dried on the grass and weeds, and the fire departments of a number of towns had their hands full. In this particular instance, the sodium chlorate was mixed with calcium chloride which was supposed to reduce the hazard. After these fires, the railroad discontinued the use of this material during hot dry weather and no further fires resulted.

In addition to the hazard of ignition of grass and weeds, and of floors of buildings where the material may have been spilled, there is a personal hazard to workers whose clothing may have become saturated with the sodium chlorate solution. This hazard is fully recognized by those who have investigated the subject. The State of Iowa Department of Agriculture advises that among the various precautions in the use of sodium chlorate, clothing saturated with sodium chlorate be washed in water before wearing again. The State of Iowa bulletin reminds the user that chlorates are flammable when combined with dry organic matter such as lumber, shoes, clothing and plant refuse. During 1937, the last year for which reports are available, 539,500 pounds of sodium chlorate were used for weed killing purposes in Iowa. The users experienced four fires; fortunately no personal injury occurred.

"Chiseled" Fire Protection.

By Percy Bugbee.

Two years ago the fire department of Boise, Idaho, received much unfavorable national publicity when a news magazine accused it of standing by while several valuable horses were burned to death in their stables. The department stood by because the fire was 25 feet beyond the city limits, the story went. The story did not mention that the fire department had not been called until the riding academy buildings were practically destroyed, nor did it go into the details of the inadequate, the almost non-existent water supply. It did not mention the fact that the Boise fire department needed all its resources to prevent embers from starting fires in the city. However, the case serves to illustrate a problem which has annoyed municipal officials for years, and continues to do so.

To protect their property, city taxpayers provide a fire department, and pay for its upkeep. As a further measure of protection they provide building laws specifying fire-safe construction. Then, as the city expands, suburbs spring up. Persons who have their businesses in the city live in the suburbs and demand that the city department, part of whose maintenance they provide, run to their homes when they catch fire. The fire department generally extends its activities this far.

Then suburban businesses, contributing nothing to city taxes, indeed taking business away from the tax paying city businesses, begin to spring up. Unrestrained by city building laws they often use cheap, "fire trap" construction. Then they "chisel" the city for fire protection. Few cities can afford to maintain a fire department large enough to protect these outside areas. Furthermore, the terms of many city charters do not allow the city to indemnify firemen who may be injured at fires outside the city. Yet the arguments of the suburbanites who own city property are hard to turn aside.

There, in its basic outline, is the problem of outside aid. It is a knotty one at best. The arguments for using the city fire department to protect its suburbs are as many as those against. Taxpayers in the city perhaps deserve the protection of the city department in the suburbs. For a department to run to protect such taxpayers' property, and not lift a finger to save the house of a near-by neighbor is ridiculous. For a department whose effectiveness depends upon promptness, to wait until it determines whether a taxpayer's property is in danger, and then make a run to the remaining ashes, is equally unthinkable.

In many places, efforts have been made to provide a definite agreement between city and suburb which will provide adequate fire protection for both

and distribute the cost equitably. Ordinarily the city enters into some sort of contract with the suburban government. The suburbs pay city fire departments by the run or by the year to have apparatus always available for their protection. In some cases they have contributed apparatus to the department of the city and regularly pay a substantial sum towards its upkeep, with the proviso that the city department keep one or more trucks always available for their fires. The city receives the advantages of using the truck bought by the outside community in fighting its own fires.

Another plan combines the city and the suburbs desiring protection into a fire district, the whole of which is taxed proportionately to property valuation for the support of the fire department. In thickly settled areas where such districts may be contiguous, the fire department of one generally has a mutual aid agreement with that of the neighbor, providing for cover-in service as well as mutual fire fighting. This cover-in service is important to a city for several reasons. When all, or most of the city's apparatus is away at a serious fire there might be a possibility of another blaze getting away to a conflagration start before apparatus could be recalled to send to it. It takes time to repack a pumper for another run. If neighboring cities have covered up in the fire stations and are held in readiness to respond to any subsequent alarm, this danger is mitigated.

In some cases the suburb maintains its own fire department. Commonly such suburbs have a mutual aid agreement with the city. In any such agreement, however, the city department is apt to be the loser, for, in general it will have plenty of modern, up-to-date apparatus for its own fires, whereas suburban apparatus may be of little value. The same applies where small towns have mutual aid agreements with big cities. Sometimes the small town may have little more fire fighting equipment than a pumper of a past generation, the mere arrival of which in the city would be a case of good fortune.

Ordinarily, American public opinion has not become sufficiently aware of the public offense which the man who has a fire commits, to attempt to charge the individual for the use of the taxpayer's equipment. The general opinion seems to be that billing a man having a fire for its use is heaping insult upon injury. However, several cities, including Dayton and Cincinnati, Ohio, enter into contracts with individuals outside their borders to provide for fire protection at a definite rate per piece of equipment. A similar plan in use in Mattoon, Illinois, charges surrounding individuals a flat rate of $50 per year to have their properties listed among those to alarms at which the fire department will respond.

Precedent in individual payment for fire protection is provided by the several rural fire districts in operation throughout the country. A number of different methods have been used in financing the purchase of rural appara-

tus, and the operating expenses. In many cases the fire protection district is authorized to levy taxes, in others the money is raised by voluntary contributions, or by plans where the assessment is voluntary, but only those contributing are entitled to protection. The N.F.P.A. Committee on Farm Fire Protection has made a special study of this problem and has developed model legislation for rural fire protection.

Often the rural apparatus is housed in the nearest center of population, and is manned by the two town fire departments. Where the cost of the apparatus is borne by the rural area, the town is generally glad to house and operate it in the surrounding rural area, in return for the use of the apparatus on fires in the town when not needed in the country.

Thus many attempts have been made to perfect fire service coöperation in town and suburban areas. Since it is obviously uneconomic for each town to provide all the fire fighting equipment it will need for fighting and standby service, mutual coöperation is a fire protection necessity. Yet care must be taken that no group be forced to pay a disproportionate share for the protection it receives. The basic considerations which must be kept in mind in providing fire protection are three: adequate service must be made available to those who need it; the cost of protection must be placed on individuals or communities according to some studied notion of who ought to bear it, and not left to chance; and the firemen ought to be given a certain degree of security from the dangers of their work.

The 1939 Fire Loss.

The preliminary estimate of the fire loss in the United States for the year 1939 is $317,539,640. This amount is based on estimates compiled by the National Board of Fire Underwriters for the first eleven months of the year, with a figure for December based upon loss experience for the same month in previous years. This total estimate is more than $15,000,000 greater than the 1938 preliminary loss estimate, and shows the result of the greater losses during the months from February to August.

Comparative Monthly Loss Estimates, 1937, 1938, 1939.

	1937	1938	1939
January	$25,069,895	$27,676,337	$27,615,316
February	28,654,962	26,472,626	29,303,520
March	29,319,029	29,050,968	30,682,168
April	26,663,854	25,616,112	27,061,522
May	21,437,739	22,917,577	27,031,700
June	19,524,765	19,473,617	24,190,700
July	19,812,485	20,434,688	22,468,304
August	19,767,314	20,821,184	22,800,500
September	19,349,756	23,372,528	22,837,250
October	21,097,670	24,797,624	24,300,500
November	23,849,673	28,658,695	27,248,160
Total 11 months	$254,547,142	$269,291,956	$285,539,640
December	30,172,952	32,758,044	32,000,000*
Total 12 months	$284,720,094	$302,050,000	$317,539,640
Adjusted loss figures (Released later in year.)	$254,959,423	$265,591,231	

Aggregate Loss for 24 Years Is Over Nine Billion Dollars.

The 1939 fire loss brings the total fire waste in the United States during the past twenty-four years up to $9,518,160,735, which is an annual average about $400,000,000. The following table gives the annual fire losses by years since 1916.

1916	$258,377,952	1928	$464,607,102
1917	289,535,050	1929	459,445,778
1918	353,878,876	1930	501,980,624
1919	320,540,399	1931	451,643,866
1920	447,886,677	1932	406,885,959
1921	495,406,012	1933	271,453,189
1922	506,541,001	1934	271,197,296
1923	535,372,782	1935	235,263,401
1924	549,062,124	1936	266,659,449
1925	559,418,184	1937	254,959,423
1926	561,980,751	1938	265,591,231
1927	472,933,969	1939 (Est.)	317,539,640

*December figure is estimated on the basis of previous years.

NOTE. It may be noted that the final loss figures for both 1937 and 1938 are less than the preliminary loss figures for those years. It may be assumed, therefore, that the adjusted loss figure for 1939 will also be lower than the preliminary estimate.

Large Loss Fires, 1939.

During the year 1939 there were reported to the N.F.P.A. Department of Fire Record twenty-one fires in the United States each involving a loss estimated at not less than $250,000. Included is an oil refinery fire at Bayonne, N. J., which occurred December 8, 1938, but which was reported to the Department of Fire Record too late for inclusion in the 1938 tabulation of large losses. This is a decrease of fifteen fires over 1938 and is nine less than the average for the past five years. Two fires in this classification occurred in Canada during 1939 and one in Alaska. The locations of these twenty-four large loss fires are shown on the accompanying annual conflagration map. Of these fires, ten resulted in a loss of more than $500,000, including three which caused losses of $1,000,000 or more. The largest loss of the year was the $3,500,000 grain elevator conflagration at Chicago, Ill., May 11, 1939.

A total of eleven lives were lost in these fires, fifty less than were lost in the large loss fires of 1938.

The following table shows the occupancies which were involved:

Warehouses	6	Oil refinery	1
Multiple occupancies	4	Grain elevator	1
Lumber and log piles	3	Whiskey distillery	1
Woodworking plants	2	Hospital	1
Metal working plants	1	Laboratory and studio	1
Group fire	1	Boat	1
Artificial leather manufacturing	1		

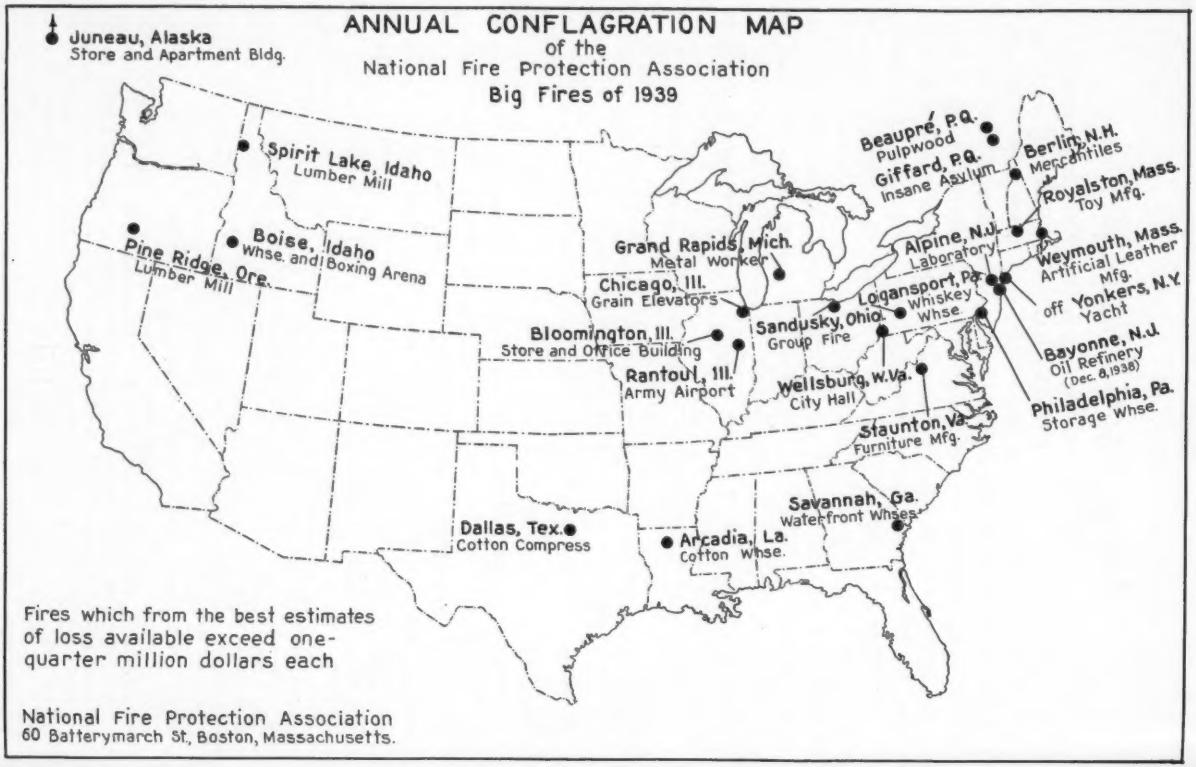
A summary of each of the fires is presented below to show the factors responsible for each large loss as far as the information is available. The loss figures in most cases are adjusted figures or authoritative estimates.

December 8, 1938, Bayonne, N. J. Tidewater Associated Oil Co. Loss: $491,000.

Although this fire occurred in December, 1938, the loss was not reported until 1939. The fire involved the filter plant at one of the several refineries located at Bayonne. It is reported that an explosion occurred in a 30-year-old oil filter plant. The filters were constructed within square brick cells, at the base of which steam pipes were located for heating the filters. Running through the filter block there were a number of oil lines, some containing naphtha solution. Apparently one of these lines started leaking, filling the filter cell with vapor which was subsequently ignited by the ignition of oil falling on the steam coils or hot brickwork adjacent thereto. The filter plant consisted of a one to three-story brick building, with reinforced concrete floors and corrugated iron roof. The fire was fought by public and private departments and their efforts to prevent the spread of the fire were successful. Twenty-five filter units were destroyed and thirty-five others damaged.

January 15, 1939, Rantoul, Ill. U. S. Army Airport. Loss: $1,000,000.

Fire of unknown origin destroyed three buildings of the Air Corps Technical School at Chanute Field, with a loss estimated by Army authorities at $1,000,000. Left in ruins were the supply depot, guardhouse and fire station. The buildings destroyed were of wooden construction, erected in 1917 as temporary structures but retained in constant use since that time. Among the supplies lost were expensive airplane parts, engineering devices, parachutes and officers' flying clothes. The large loss may be attributed to the highly combustible construction of the buildings involved, which allowed flames to spread with great rapidity, and the valuable nature of the contents.


ANNUAL CONFLAGRATION MAP
of the
National Fire Protection Association
Big Fires of 1939
Juneau, Alaska
Store and Apartment Bldg.
Spirit Lake, Idaho
Lumber Mill
Boise, Idaho
Whse. and Boxing Arena
Pine Ridge, Ore.
Lumber Mill
Grand Rapids, Mich.
Metal Worker
Chicago, Ill.
Grain Elevators
Bloomington, Ill.
Store and Office Building
Rantoul, Ill.
Army Airport
Sandusky, Ohio
Group Fire
Wellsburg, W.Va.
City Hall
Loganport, Pa.
Whiskey Whse.
Beaupré, P.Q.
Pulpwood
Giffard, P.Q.
Insane Asylum
Alpine, N.J.
Laboratory
Berlin, N.H.
Mercantiles
Royalston, Mass.
Toy Mfg.
Weymouth, Mass.
Artificial Leather Mfg.
off Yonkers, N.Y.
Yacht
Bayonne, N.J.
Oil Refinery
(Dec. 8, 1938)
Philadelphia, Pa.
Storage Whse.
Staunton, Va.
Furniture Mfg.
Savannah, Ga.
Waterfront Whses.
Dallas, Tex.
Cotton Compress
Arcadia, La.
Cotton Whse.
Fires which from the best estimates of loss available exceed one-quarter million dollars each
National Fire Protection Association
60 Batterymarch St., Boston, Massachusetts.

MILLION DOLLAR FIRES, 1930-1939.
Bristol Bay, Alaska
Salmon Cannery, 1936.
Tillamook County, Ore. - Forest Fire, 1933
Salem, Ore. - State Capitol, 1935.
Pine Ridge, Ore. - Lumber Mill, 1939
Bandon, Ore. - Conflagration, 1936.
Oakland, Calif. - Pier and Ferry, 1933
Southern California - Brush Fires, (2) 1935
Brush Fire, 1938.
Menominee, Mich.
Lumber Mill, 1931.
Greenfield, Wis.
Corn Mill, 1937.
Chicago, Ill.
Elevator & Racking House, 1932.
Stockyards, 1934.
Grain Elevator, 1939.
Peoria, Ill.
Whiskey Distillery, 1935.
Springfield, Ill.
State Arsenal, 1934.
Near Owensboro, Ky.
Whiskey Distillery, 1938.
Port Alfred, Que.
Pulpwood Pile, 1932
Buffalo, N.Y.
Armory, 1931
Wellsville, N.Y.
Oil Refinery, 1938.
Rantoul, Ill.
Army Airport, 1938.
South River, N.J.
Brick Plant
1934
Cincinnati, Ohio
Oil Fire (Flood)
1937.
Altoona, Pa.
R.R. Shop, 1931.
Lexington, Ky.
Whiskey Warehouse 1934
Newport News, Va.
Steamship, 1931.
Norfolk, Va.
Conflagration, 1931.
Birmingham, Ala.
Department Store
1934
New Orleans, La.
Wharf Warehouses (2) 1930
Ellsworth, Me.
Conflagration, 1933.
Auburn, Me.
Conflagration, 1933.
Nashua, N.H.
Conflagration, 1930.
New London, Conn.
Conflagration, 1938.
New York, N.Y.
Steamship, 1930.
Pier and Wharf 1932
Coney Island
Conflagration, 1932.
S.S. Morro Castle
1934
Bayonne, N.J.
Refinery - 1930.
Lakehurst, N.J.
Zeppelin
Hindenburg, 1937.
Paulsboro, N.J.
Linoleum Factory
1934.
Fires which from the best estimates of loss available exceeded one million dollars each.
National Fire Protection Association.
60 Batterymarch St., Boston, Massachusetts.

This log pile at Beaupré, P. Q., consisting of some 61,000 cords of pulpwood, was almost entirely destroyed by a fire which burned from February 1 to 4, 1939, with a loss amounting to $530,000.

February 1-4, Beaupré, P. Q., Canada. Ste. Anne Paper Co., Ltd. Loss: $530,000.

Soon after dynamite was used to loosen frozen pulp wood in a log pile containing some 61,000 cords, fire was discovered. Although seventeen hose streams were finally brought into play, the fire burned for four days and consumed about 57,000 cords of pulpwood, including about 2500 cords in an adjacent pile. Due to the lack of adequate piping it was impossible to make use of the total available water supply, although some temporary piping was laid during the fire to permit the use of additional hose lines. Of the possible 16,000 gallons per minute of water available, a maximum of 4450 gallons per minute was used. This fire serves to illustrate the need of adequate facilities for quickly applying an ample number of effective streams upon discovery of a fire in a pulpwood pile. It also demonstrates the fallacy of large piles of pulpwood. Pulpwood piles should be limited in size, well separated and so arranged that all parts can be quickly reached by fire streams. This fire again illustrates the hazard of using dynamite to loosen pulpwood, particularly if the wood is old and contains bark and chips.

February 3, Bloomington, Ill. Durley Bldg. Loss: $293,000.

Fire of unknown origin started in the basement of this mercantile and office building, resulting in the complete destruction of all contents and extremely heavy loss to the building. The building was a three-story brick-joist structure with unprotected floor openings. The late discovery of the fire and the large interior open court were contributing causes to the heavy loss.

February 8, Juneau, Alaska. Goldstein Stores & Apartments. Loss: $300,000.

Fire originating in a mattress in the basement of this five-story building resulted in severe damage to both building and contents. The building was of reinforced concrete construction with laminated wood floors. About three hours before the fire was discovered, a mattress was found to be burning in one of the apartments. The mattress was removed to the basement and soaked with water and the contents of a soda-acid extinguisher. Apparently some sparks remained, for in about three hours smoke was discovered coming from the basement room where the mattress had been stored. Before first aid appliances could be used the smoke and flames became unbearable. The fire spread up two elevator shafts and involved the third floor before the fire department was able to bring its equipment into play. All available reports state that the fire department performed excellent service in keep-

Part of the burning St. Michel l'Archangel Hospital for the insane at Giffard, P. Q., after the fire had been burning all through the day of February 16, 1939. Much of the institution was destroyed with more than $500,000 loss.

ing the loss as low as it was. They were assisted by the U. S. Coast Guard, Citizens Conservation Corps and miscellaneous volunteers. The large loss may be attributed to the unprotected elevator shafts, which allowed the fire to spread rapidly, and the relatively high value of the contents, which included a stock of choice furs.

February 16, Giffard, P. Q., Canada. St. Michel l'Archangel Hospital. Loss: $525,000.

Fire, believed to have been of incendiary origin, destroyed a large part of this hospital for the insane. The large financial loss was secondary to the tremendous problem of moving and caring for the nearly 3000 inmates. The buildings involved were old brick-joist structures completely lacking all features of fire-safe construction. To this fact, plus a high wind and severe cold, may be attributed the large loss. (April, 1939, QUARTERLY, page 377.)

March 3, Staunton, Va. Basic Furniture Co. Loss: $455,000.

Spontaneous ignition of lacquer residue as a result of spraying hydrogen peroxide in the spray booth regularly used for lacquer spraying, is believed to have been the cause of a fire which destroyed nearly all of this plant. The building involved was a frame metal-clad factory building equipped with sub-standard sprinkler protection, but lacking cut-offs. There was no failure in the operation of the sprinkler system, but the rapid spread of the fire over a large area caused so many heads to fuse as to overtax the water supply. Fire fighting operations were handicapped by the natural terrain surrounding the plant, which made it difficult to maneuver apparatus, and the lack of a sufficient number of available hydrants. The only property saved was a dry kiln and a detached lumber yard. (For detailed discussion of hydrogen peroxide bleaching of furniture and attendant hazards, see October, 1939, QUARTERLY, page 110.)

March 12, Alpine, N. J. Estate of Dr. J. C. Burnett. Loss: $500,000.

Fire of undetermined origin practically destroyed a private electrical research laboratory and a studio containing works of art and statuary. The large loss may be attributed to the remote location of the property, the lack of adequate water supply and the valuable nature of the contents. The buildings involved were of heavy stone exterior construction, the laboratory having wood floors and roof, the studio having five-inch concrete floors poured over two-inch wood planking and supported by concrete piers and wooden columns. The studio was used two days each week for the processes of waterproofing and restoration of statuary. These processes involved the use of several flammable materials, including

International.

These buildings in downtown Sandusky, Ohio, were destroyed by fire March 21, 1939. Lack of fire walls and parapets permitted the fire to spread, resulting in a loss of $750,000.

paraffin, alcohol, benzene, acetone, and turpentine. Electric heaters were used in the preparation of the solutions and in preheating the statuary preparatory to treatment. It was stated that these heaters were not in use the night before the fire. Early on the morning of March 12, fire started on the first floor of the studio building and spread to the laboratory building. Forty minutes elapsed before the first piece of apparatus arrived on the scene, which was subsequently reinforced by two additional pumpers. However, the water supply became insufficient after several hours of continuous pumping and was finally exhausted. The fire burned itself out about noon the following day.

March 21, Sandusky, Ohio. Conflagration. Loss: $750,000.

A minor conflagration of unknown origin destroyed five fairly large retail mercantile establishments and other property in a congested down-town block. All buildings were of ordinary brick-joist construction, mostly three stories in height. The fire originated in a four-story building with a large light well extending from the first floor to the roof. This was one of the major causes of the large loss, as it allowed the fire to spread with such rapidity that it was beyond control before the fire department arrived. Despite the efforts of the firemen, the flames spread to adjacent buildings and involved at least two-thirds of the block. Standard fire walls and parapets, and proper protection of exposed openings would have aided materially in preventing the spread of the fire, but these were completely lacking.

March 25, Royalston, Mass. Mason & Parker Mfg. Co. Loss: $316,782.

A large two to three-story frame woodworking factory, manufacturing toys and beach chairs, was almost totally destroyed by fire because automatic sprinkler and private outside protection was out of commission. The fire apparently started in a section of a building used for finishing and woodworking. The cause is not known. It quickly involved practically the entire plant, the rapid spread being attributed to the highly flammable materials in the finishing rooms. Despite the attempts of the village fire department to prevent it, the

fire spread across the Millers River and involved another group of buildings. It is probable that the fire communicated between the two groups of buildings by means of a frame connecting bridge as well as by flying brands. Only three detached storehouses and some sheds and lumber were saved. The sprinkler and private yard protection had been out of commission for several weeks, due to a broken main connecting the groups of buildings on each side of the river. The main was to have been repaired on March 27, two days after the fire.

May 5, Logansport, Pa. Pennsylvania Distilling Co., Inc. Loss: $700,000.

Fire destroyed a rack warehouse and a cistern building at this whiskey distillery. Presumably discovered when small, the fire burned for an hour and a half after the first volunteer fire company arrived before anyone with authority could be located to give the firemen permission to enter the Government-bonded warehouse. By that time the fire was beyond control. Considering the isolated location of the plant, inadequate preparations for fire defense, and the delay in beginning fire fighting operations, it is fortunate that the entire plant was not destroyed. (July, 1939, QUARTERLY, page 58.)

May 11, Chicago, Ill. Rosenbaum & Norris Elevators. Loss: $3,500,000.

A series of grain dust explosions in an elevator resulted in the loss of nine lives and caused a conflagration which destroyed five large elevators. The five elevators destroyed were of the old type cribbed construction with walls of wood, metal clad, and with masonry foundations. The large loss may be attributed to the initial explosions, which disrupted the sprinkler systems provided in the first three elevators involved, the tremendous size of the buildings, which could not be adequately protected by hose streams, the severe exposure, and the lack of remote control for the sprinkler valves. If it had been possible to shut off the damaged sprinklers in the first elevator water could have been supplied to the water curtain, which was supposed to have protected the adjacent elevators. (See July, 1939, QUARTERLY, page 33, and October, 1939, QUARTERLY, page 122.)

June 21, Philadelphia, Pa. Miller North Broad Storage Co. Loss: $600,000.

The owners of valuable personal property, furniture and furs destroyed in this fire have instituted legal proceedings to compel the warehouse company to reimburse them for the value of their property destroyed. They claim that they relied upon the company's advertising that its building was fireproof and therefore did not secure fire insurance on the goods they placed in storage. As a result of this pending litigation, the N.F.P.A. Department of Fire Record has not been able to secure complete information, although the Philadelphia Fire Department has made a circumstantial report of their operations. The fire started from some undetermined cause on the third floor and spread up the elevator shaft to the fifth and sixth floors through open fire doors. It is reported that these doors were of the automatic type, and that there was some failure of the fusible links or closing mechanism. No information is available as to whether the failure was due to lack of inspection and maintenance, to some obstruction of the doors, or to unapproved or obsolete equipment.

The fire was severe. The Philadelphia Fire Department, responding to the first alarm at 5:44 A.M., was seriously handicapped by solid walls, which prevented access and made adequate ventilation impossible except on the sixth floor, where holes were made in the roof. There were interior curtain walls which interfered with fire fighting operations but did not restrict the spread of the fire. There were no automatic sprinklers, except in a lower garage section not involved in this fire. Thirty-four men were injured or overcome by smoke during the four-alarm fire.

The loss to the building was adjusted at $140,343.77. The building was a six-story reinforced concrete structure, 31,500 square feet in area, valued at $211,000. A loss to the building of two-thirds its value in a fire which only involved three of six floors would indicate a degree of heat that could only be caused by the burning of a heavy concentration of combustible contents. At the conservative figure of $5.00 per sq. ft. contents value, the contents loss may be estimated at $472,500, making the total loss $613,000, exclusive of any loss due to interruption of business or other indirect losses. As it was reported that the contents included furs, the figure of $5.00 per sq. ft. may be far too conservative. When, if ever, the true figures will be available will depend upon the progress of this litigation in the courts.

July 11, Weymouth, Mass. Weymouth Art Leather Co. Loss: $450,000.

The severe hazard of intense, fast-spreading fires in plants handling cellulose nitrate materials, and the imperative need in such plants for the segregation of hazards into small

areas by cut-offs and special sprinkler protection backed up by powerful water supplies, was illustrated by this fire. Believed to have started from a flash fire ignited by an electric spark in a scrap pyroxylin churn, the fire quickly spread beyond the control of the substandard sprinkler equipment due to the severe hazards and limited water supply. The plant in which this fire occurred consisted of a group of buildings of indifferent frame, ironclad, cement block, and brick-joisted construction. The fire record over a period of twenty-five years was not good. The limited sprinkler protection was not designed to control greater than ordinary hazards and hence was ineffectual in checking the fire. (October, 1939, QUARTERLY, page 130.)

July 20, Arcadia, La. Arcadia Bonded Warehouse. Loss: $365,000.

Fire of undetermined origin destroyed a sprinklered warehouse containing some 7000 bales of cotton. The sprinkler system was supplied only from a municipal water main under 58 pounds pressure with fair volume. Although the effect of the sprinklers was impaired by high tiering of the bales without adequate aisleways, it is reported that the large loss was due to the action of the volunteer fire department that responded to the alarm in reducing the sprinkler water supply by laying two hose lines from a hydrant, and not supplying increased water pressure to the sprinklers through the fire department connection.

August 10, Boise, Idaho. Warehouse and Boxing Arena. Loss: $297,000.

A large frame iron-clad warehouse, in one end of which a public boxing arena had been built, was totally destroyed by a fire which started while a boxing contest was in progress. When smoke was noticed seeping into the arena from the rear section of the building, the more than five hundred spectators were evacuated in an orderly manner. The fire had apparently gained great headway in the section of the building used for the storage of government supplies of uniforms, shoes, trucks, and camp equipment before being discovered. It is reported that the fire was beyond control by the time the first pumper arrived. Firemen were forced to concentrate their efforts on the protection of exposed property, which included oil and gasoline storage tanks. The fire consumed the warehouse and arena and spread to an adjacent lumber yard.

August 18, Spirit Lake, Idaho. Panhandle Lumber Co. Loss: $320,000.

A forest fire, which burned over 25,000 acres, destroyed 16,000,000 feet of lumber at this large mill and plant. Fire departments from two towns were reported to have saved the mill and other buildings.

August 19, Pine Ridge, Ore. Forest Lumber Co. Loss: $2,000,000.

This large lumber manufacturing plant, consisting of sawmill, dry kilns, planing mill, box factory, lumber sheds and lumber yard, and having its own townsite, was almost totally destroyed by a fire of unknown origin which occurred during a week-end while many employees were away. Nearly all major units of the plant were of frame construction and were, for the most part, sprinklered. The fire protection facilities were extensive, but when fire originated in the lumber yard the available man power, not organized, was unable to cope with the blaze. The severe exposure from the burning of approximately 24,000,000 feet of high-piled lumber proved too much for the sprinkler system inside the exposed plant buildings. Driven before the wind, the fire crossed a river to involve the townsite and continued to spread five miles through the forest until it stopped at the shores of a lake. This fire demonstrates the need for trained private fire brigades and the isolation of large lumber yards from other plant units. (October, 1939, QUARTERLY, page 105.)

August 26, Dallas, Texas. Farmers' & Merchants' Compress & Warehouse Co. Loss: $285,000.

An early morning fire of undetermined origin severely damaged a cotton compress plant and warehouse, and destroyed some 5300 bales of cotton. With the effective protection provided by cut-offs and fire doors, firemen were able to confine the blaze to one section, comprising about an eighth of the huge building. Firemen had some difficulty reaching the plant with water, as it is located a considerable distance from hydrants.

October 15, Savannah, Ga. R. R. Warehouses. Loss: $290,377.

Fire of unknown origin occurred in a large waterfront warehouse containing 3700 tons of nitrate of soda and spread to an adjacent warehouse containing a like amount of muriate of potash. In addition two other small buildings and several railroad freight cars were destroyed. The fire was discovered in its early stages, but the buildings, being of ordinary frame construction, burned readily and, aided by the nitrate of soda, the fire quickly reached

Firemen are here shown fighting the fire which severely damaged a multiple occupancy building at Berlin, N. H., on November 9, 1939. The fire started near the furnace in the basement under the J. C. Penney Co. store. Being unfamiliar with the building, firemen tried vainly to reach the fire with a hose stream through the floor of Emma's Restaurant. The fire spread through the floor joist channels and the final loss was estimated at $250,000.

conflagration proportions. The fire department was able only to prevent the spread of the fire beyond the two principal buildings involved on their arrival. This fire emphasizes the advisability of storing nitrates and such hazardous commodities in compartments of small area, separated by fire walls, and the need for considerable clear space between buildings.

October 21, Yonkers, N. Y. Yacht "Q.E.D." Loss: $250,000.

This unique craft was the property of the airplane manufacturer, the late Anthony H. G. Fokker, and was built from plans incorporating many of the principles of airplane design. Because of the many unusual features and the selected quality of the materials used, the yacht was particularly costly to build, representing an investment of some $250,000. When just four months old, while proceeding up the Hudson River, the vessel suddenly burst into flames. All on board, with the exception of one member of the crew, saved their lives by leaping overboard. Severely damaged by the fire, the yacht sank in midstream while being taken in tow.

October 30, Grand Rapids, Mich. McInerney Spring & Wire Co. Loss: $606,000.

Fire starting in a japan bake oven destroyed this factory and caused one of the largest industrial fire losses of the year. This large sprinklered plant was engaged in the manufacture of wire coil springs. A minor explosion in a japan bake oven ignited an adjacent dip tank. Automatic foam protection at the dip tank failed to operate. The tank was located in a large room and more sprinkler heads opened than could be effectively served by the existing water supply. Conveyors piercing fire walls further contributed to the spread of the fire throughout the plant. (January, 1940, QUARTERLY, page 295.)

November 9, Berlin, N. H. Morin Bldg. Loss: $250,000.

This three-story brick-joist mercantile and office building was severely damaged by fire which originated in the basement near the furnace. The fire department promptly cut a hole through the floor and directed water into the basement. Being unfamiliar with the plan of the building, however, they failed to cut into the furnace room and their hose stream did not reach the fire. The fire spread through floor joist channels and eventually involved the roof. This fire illustrates the importance of inspections by fire departments and the maintenance of records to show the lay-out of all buildings.

December 7, Wellsburg, W. Va. City Hall. Loss: $300,000.

Fire of unknown origin partially destroyed this three-story brick-joist building within about ninety minutes from the time of discovery. Smoke was first discovered pouring from the base of the clock tower. Within fifteen minutes the entire third floor, which was a large ballroom, was a mass of flames. In ten minutes more the clock tower collapsed, giving rise to the belief that the wooden supports had been almost burned through before the fire was discovered. A high wind was blowing which scattered sparks over a wide area, but the firemen were alert and only one additional fire was started with small loss. The water supply was adequate at all times, and the large loss is attributable to the construction of the building, the delayed discovery of the fire and the prevailing high wind.

Factors Responsible for the Large Losses.

Following the practice of several years, an analysis has been made of these fires to determine the factors responsible for the large losses. In most instances several factors contributed to the rapid spread of the fire and the extensive loss. The factors most frequently contributing to large losses were "inferior construction, excessive areas," "highly combustible contents, excessive amounts of burnable stocks," and "lack of adequate private protection."

The accompanying table indicates the frequency of the most important factors responsible for the losses running to at least $250,000.

Reasons for Large Loss.	No. Times Contributing
Structural Factors	41
Inferior construction, excessive areas, etc.	17
Lack of sufficient exposure protection	11
Unprotected vertical openings	11
Wooden shingle roofs	2
Occupancy Factors	26
Highly combustible contents, excessive amounts of burnable stocks	17
Flammable liquids	7
Spread of flames enhanced by accumulations of dust	1
Unsafe heating equipment	1
Fire Protection	39
Lack of adequate private protection	17
Lack of fire doors or cut-offs between sections	15
Lack of adequate public protection	3
Sprinkler system of obsolete type or inadequate design	3
Sprinklers shut off	1
Fire Fighting	19
Fire difficult of access for fire fighters	8
Poor fire fighting by employees	3
Fire department inadequately manned or equipped	1
Inexperience in fighting fires of such magnitude	4
Fire department delayed	3
Delays in Giving Alarm	12
Headway of fire when discovered	11
Effort made to extinguish fire without giving alarm	1
Water Supplies	15
Inadequate water supplies	4
Shortage of hydrants	11
Explosions	4
Strong wind	8
Intense cold	3
Low humidity	1

Building and Contents Losses.

From time to time the N.F.P.A. Department of Fire Record receives inquiries as to the division of fire losses between buildings and their contents. As shown by the figures of seven typical states separately reporting building and contents losses for the year 1938, and representing a total loss experience in excess of twenty-one million dollars in that year, building losses represented 65.1 per cent, or very nearly two-thirds of the total. The records of the seven individual states are given below. These records are taken from the annual reports of the state insurance commissioners or fire marshals.

Building and Contents Losses — Seven States, 1938.

State	Building Loss	Per Cent	Contents Loss	Per Cent	Total Loss
Iowa	$2,673,154	63.8	$1,506,496	36.2	$4,179,650
*Indiana	1,553,796	70.8	641,814	29.2	2,195,610
Massachusetts	7,452,772	66.1	3,835,626	33.9	11,288,398
Montana	433,599	67.6	208,671	32.4	642,270
New Hampshire	950,653	65.2	507,563	34.8	1,458,216
Oklahoma	221,050	51.9	206,733	48.1	427,783
West Virginia	696,043	52.8	625,760	47.2	1,321,803
Total	$13,981,067	65.1	$7,532,663	34.9	$21,513,730

*Fiscal year ending June 30, 1939.

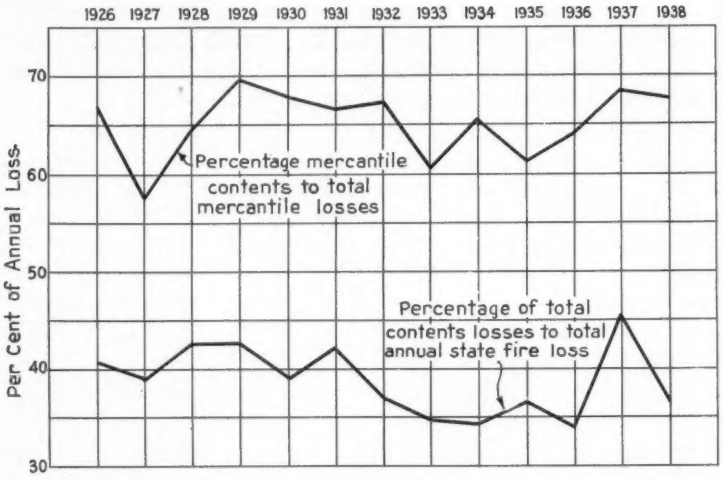
The division of losses between buildings and contents varies considerably in different occupancies. For example, the single occupancy representing the greatest bulk of fire loss experience is dwellings. The following table shows the breakdown of dwelling losses between building and contents in four typical states reporting this information in 1938. This table shows that three-fourths of all dwelling fire loss is damage to the building and only one-quarter of the loss is to contents. This division of losses not only reflects the greater values at stake in dwelling structures as compared with contents, but reflects the fact that contents are frequently removed to safety in rural dwelling fires which so frequently result in total structural losses.

Building and Contents Losses in Dwellings — 1938.

State	Building Loss	Per Cent	Contents Loss	Per Cent	Total Loss
*Indiana	$725,403	79.8	$183,984	20.2	$909,387
Iowa	1,037,043	74.7	349,700	25.3	1,386,743
Massachusetts	2,561,231	74.8	874,270	25.2	3,435,501
New Hampshire	391,735	75.8	125,475	24.2	517,210
Total	$4,715,412	75.6	$1,533,429	24.4	$6,248,841

*Fiscal year ending June 30, 1939.

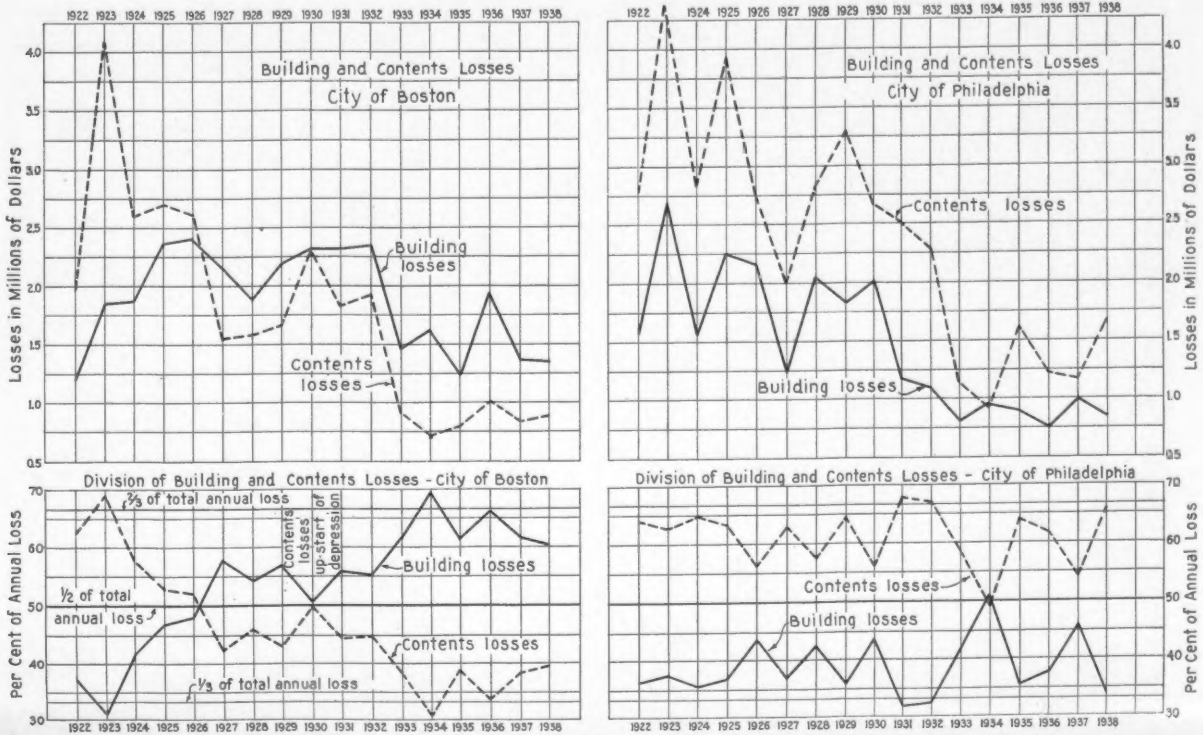
In mercantile properties the division of losses between buildings and contents shows nearly the opposite proportion in that it is the mercantile stocks that form the greatest portion of the total damage, accounting for about two-thirds of the loss in mercantile properties. The following chart, covering the state of Iowa, indicates the percentage of contents losses in the case of mercantile fires as compared with the percentage of contents losses to the total annual state fire loss in all classes of property.


1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938
70
60
50
40
30
Per Cent of Annual Loss
Percentage mercantile contents to total mercantile losses
Percentage of total contents losses to total annual state fire loss

Trends in Building and Contents Losses.

The division of losses between buildings and contents has not remained constant in any one locality throughout a period of years because building and contents losses obviously reflect the factors that have been influencing fire loss trends. It seems reasonable to assume that improved fire protection, for example, might have an effect upon the ratio of building and contents losses. To show how building and contents losses fluctuate data are presented in the form of loss experience in the large cities of Philadelphia and Boston. The records of these cities are of interest because due to business activities, contents losses form a more important segment of their annual loss experience than is the case in smaller communities or rural areas which influence state-wide fire loss.

A chart showing the fire loss experience since 1922 in the cities of Philadelphia and Boston follows. The upper portion of each chart shows the annual building and contents losses for the two cities in millions of dollars. The lower portion of the chart shows the percentage of the annual fire loss due to building and contents losses.


Building and Contents Losses
City of Boston
Losses in Millions of Dollars
Building losses
Contents losses
Building and Contents Losses
City of Philadelphia
Contents losses
Building losses
Losses in Millions of Dollars
Division of Building and Contents Losses - City of Boston
Per Cent of Annual Loss
⅔ of total annual loss
Contents losses up-start of depression
Building losses
½ of total annual loss
Contents losses
⅓ of total annual loss
Division of Building and Contents Losses - City of Philadelphia
Contents losses
Building losses
Per Cent of Annual Loss
1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938

Chemicals in Forest Fire Control.

By T. R. Truax,*
(Member N.F.P.A.).

Forest fire fighting in regions where water supplies are sparse involves special problems altogether different from those found in fighting fires in cities and towns. Where the only water available is that carried by the fire fighters in back packs, the maximum possible efficiency in the use of water is of utmost importance and anything which can be done to increase the extinguishing effectiveness of a given weight of liquid may in some cases be a deciding factor in forest fire control. Mr. Roy Headley, chairman of the N.F.P.A. Forest Committee, has in his recent annual reports to the Association referred to various experiments undertaken by the U. S. Forest Service to determine whether foam and various other chemical solutions might be more effective than water in practical forest fire fighting. This investigation, initiated by the Forest Service in 1936, has been carried on during the past three years by the Forest Products Laboratory in coöperation with various other divisions of the Forest Service and the Michigan Department of Conservation.

The investigation included a review of previous literature and search for promising materials, laboratory tests to compare the effect of various compounds and to study variables in extinguishing fires, and field tests to compare the results of the more promising materials on natural fuels of different types and arrangement.

After a thorough review of the literature on various gases, liquids, solids, and foams that have been used or suggested as fire extinguishers and retardants, some 40 different chemicals or combinations of chemicals in water solution were tested in the laboratory on a standard wood fire and with a uniform technique of extinguishing. The laboratory tests also involved different concentrations of solutions of the most effective chemicals, variations in rates of application of solutions and extinguishing under varying wind velocities.

The method of test was an adaptation of that used by Folke in a study of the factors involved in fire extinction (QUARTERLY, October, 1937, p. 115). The standard fuel pile consisted of 18 pieces, 1 by 1 by 6 inches in size, of clear, surfaced, southern pine wood. After conditioning to 6 to 7 per cent moisture content, the pieces were selected by density to give a total weight of approximately 990 grams (2.18 pounds) for the 18 pieces. The pieces were arranged in the form of a crib — 3 in a layer and 6 layers high on a wire screen

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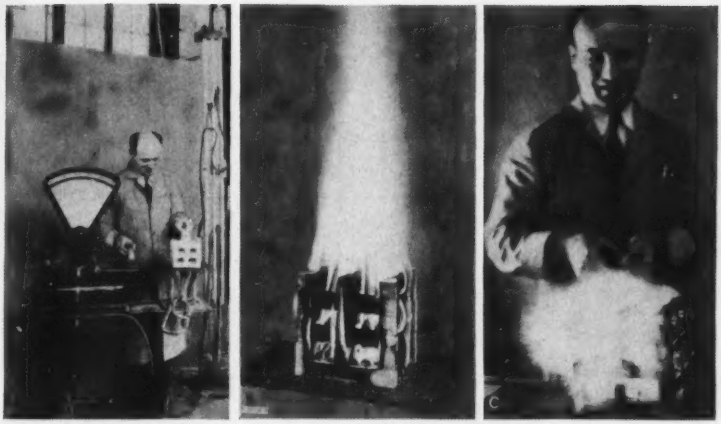


Laboratory method used in testing the effectiveness of chemical solutions:

A. Test assembly, showing a wood crib nearing completion, scales, battery of gas burners for igniting, and burettes for measuring volumes of extinguisher liquids.

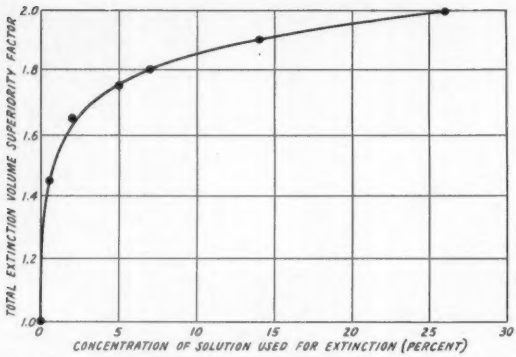
B. Appearance of crib burning in quiet air just preceding application of extinguisher.

C. Early stages of extinction under a wind velocity of 10 miles per hour.

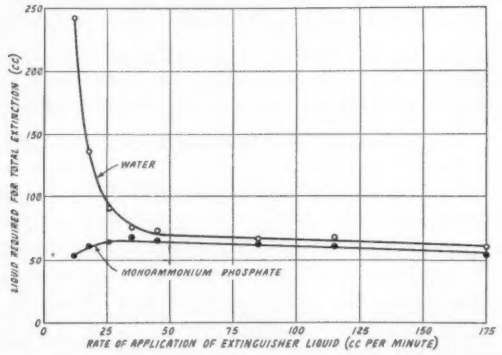
attached to the platform of a scale that permitted continuous reading of the weight during test. The wood was ignited by means of a battery of 4 gas flames placed directly beneath the crib for 1 minute. The burning was allowed to progress until 50 per cent of the original weight of the crib was lost, at which time extinguishing began. The liquid was applied as a small jet from a glass nozzle at a predetermined and controlled rate.

Data were recorded of the volume of liquid used for flame extinction and for total extinction (including glow), of elapsed time for flame and for total extinction, and of the crib residue remaining after complete extinction. A series of several tests was made with each chemical solution and concentration. Similar tests were made using water as the extinguishing agent, to afford a basis for evaluating the effectiveness of the chemical solutions.

The effectiveness of a chemical was determined by comparing the volume of its solution with the volume of water required for flame and total (flame and glow) extinction of similar fires. The results of the laboratory tests showed the solutions of some chemicals to be about twice as effective as water for total extinction. In tests with varying rates of application and wind velocities advantages as high as four times were obtained for the most effective chemical solutions in total extinction. A few chemicals showed superior flame extinction, but this advantage was largely lost in totally extinguishing the heavy glow in



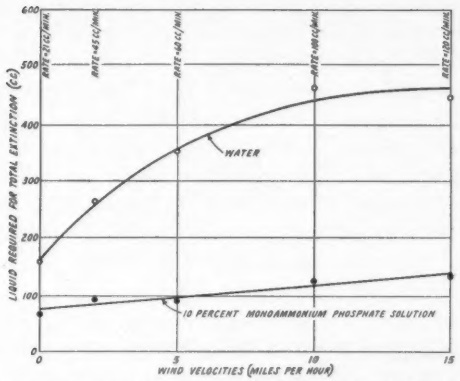
Relation between total extinction volume superiority factors and the concentration of monoammonium phosphate solution.



The variation in volume of 10 per cent monoammonium phosphate solution and water required for total extinction, with change in rate of application.

the wood test fires. Some of the chemicals tried showed no advantage over water, and citric acid, tartaric acid and ammonium nitrate were less effective than water. Chemicals for field tests were selected on the basis of their showing in the laboratory tests. Monoammonium phosphate, which showed little superiority over water for flame extinction in quiet air, showed high superiority for both flame and total extinction in a later series of tests made under substantial wind velocities.

More than two thousand field tests were made on grass and palmetto-grass fuels of the South; hardwood leaf litter of the Appalachian region, slashings of the Lake States, Appalachian, and Pacific Northwest; logs and branches, bracken, and rotten wood of the Pacific Northwest; and pine duff and brush of California.



Average amount of water and of 10 per cent monoammonium phosphate solution required for total extinction at different wind velocities.

Fires were set in the fuels in their natural arrangement and condition, where it was feasible and practicable to do so. This was true for all tests in grass, palmetto-grass, hardwood leaf litter, pine duff, and brush. Slashings, logs and branches, bracken, and rotten wood were artificially arranged, however, either because of their nonuniform natural distribution or on account of the hazard connected with burning them in their natural arrangement under the conditions prevailing at the time of test.

Direct Extinguishing Tests.

The procedure used in direct extinguishing field tests was modified from time to time as the work progressed, experience was gained, and additional equipment became available. For most of the tests an experimental unit, consisting essentially of a small air compressor, pressure tanks for liquids, hose and nozzles was employed. Various types of nozzles were used, but one, which was adjustable over a wide range in rate of flow of liquid, was used extensively in the field tests. In some tests, back packs were used and in a few tests power pump equipment was employed. These were all included in a portable field laboratory containing a variety of equipment for preparing and applying solutions and foams and taking the measurements and data required.

In the early field tests, alternate fires were extinguished with chemical solution and water, respectively. Considerable difficulty was experienced, however, in obtaining successive fires of equal severity, due to wind conditions at the time of test and to other factors. A method of making two tests simultaneously — one with chemical solution and one with water — was finally evolved in the later experiments. This method largely overcame the irregularity due to wind. The two fires started at the same time were extinguished simultaneously by two operators with similar equipment, one using water and the

other chemical solution. For succeeding tests, the operators alternated water and chemical solution regularly, each extinguishing the same number of fires with each liquid in a series of tests.

Considerable care was exercised to have fires of comparable size and severity for extinguishing with water and chemical solution. Areas of naturally arranged fuels were selected to obtain as much uniformity as possible. Artificially piled fuels were selected to get uniform kinds and quantities of material and to have them arranged in like manner for corresponding water and chemical fires. With all the care used, however, it was felt that large differences were common in the test fires, particularly in the naturally arranged fuels. Furthermore, no constant relation between rate of application of liquid and size of successive fires could be attained and the wind velocity and direction fluctuated considerably, both during a single test and from one fire to the next. These variations caused wide fluctuations in the results in successive tests and series of tests that were intended to be alike.

The table on the next page shows the average results obtained in the numerous field tests on different fuels with several chemical solutions and foams. The values, shown as superiority factors, represent the ratios of quantities of water and chemical solution required for total extinction of test fires. For example, a factor of 1.5 indicates that 50 per cent more water was used than chemical solution in extinguishing the test fires. A range of values, as 1.2 to 1.6, indicates that the results varied as shown in different series of tests, made at different times and under somewhat different conditions.

While there are definite limitations to the data, because of nonuniform test conditions, certain important indications are nevertheless evident. Chemical solutions and foams show different results on different fuels. The pronounced glow-retardant chemicals, of which monoammonium phosphate was selected as representative, were most effective on the glowing types or combinations of glowing and flashy types of fuels, such as fresh pine slashings, but showed substantially increased effectiveness over water on all fuels tried, except rotten wood. Foams were of most value on logs and branches and rotten wood, where the burning surfaces could be coated with a continuous layer of the foam. In green slashings, bracken, and similar materials, where the fuel is thick and matted, the foam cannot be applied readily to the burning surfaces and has little or no advantage over water. In general, the best results with foam were obtained when the combined foam-forming and fire-retardant chemical solutions were expelled as a liquid or as a partially expanded foam. Considering the range of fuels and concentrations of solutions tested, monoammonium phosphate was the most effective material tested; furthermore, it is moderate in cost, appears to be otherwise suitable, and is the most widely applicable.

Pretreatment Tests.

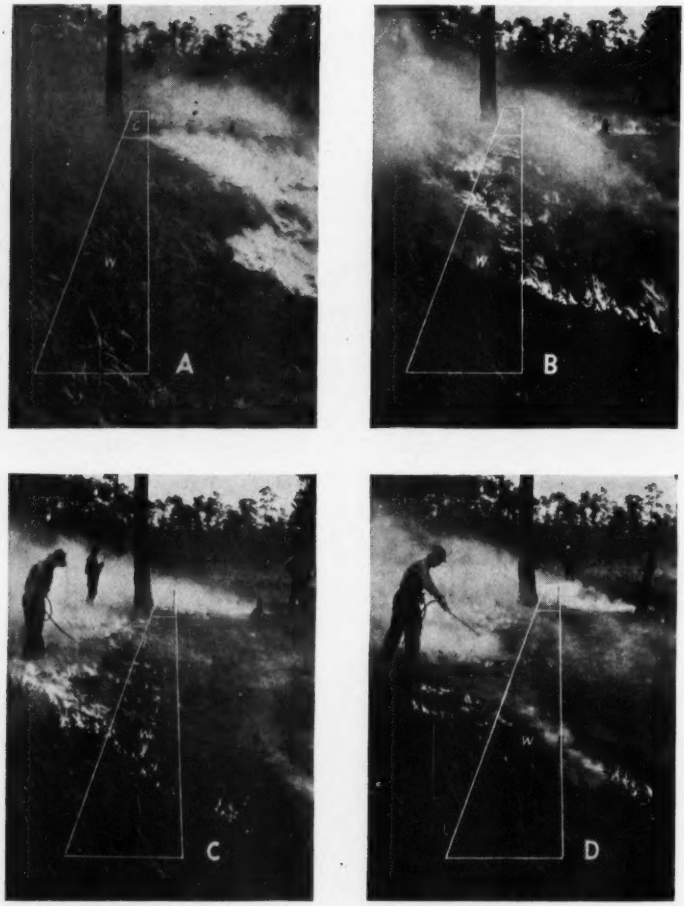
Field tests were also made in which the fuels were pretreated in advance of an oncoming fire. These tests were made in several ways to determine the value of chemicals in holding a line from which to backfire or to act as a barrier or firebreak. Of the chemicals tried, phosphoric acid and its ammonium salts were found most effective. In pretreated strips of grass and pine duff, in which the water was allowed to evaporate before test, moderately severe fires were completely stopped by the fire-retardant chemical. Lines freshly treated with monoammonium phosphate solution, from which backfires were set, were much more easily held than lines treated with water alone.

Comparative Effectiveness of Chemical Solutions and Foams in Direct Extinction Field Tests.

Extinguisher		Superiority factors[1] based on volumes of water and chemical solutions used for total extinction on—								
Chemical	Concentration	Grass	Palmetto-grass	Hardwood leaves	Pine duff	Coniferous slashings	Logs and branches	Bracken	Brush	Rotten wood
	Pct.									
Ammonium phosphate, mono-.	2.5	1.2	....	1.3	.....	1.2–1.6	.....	.....	....	....
	5.0	1.3–1.5	1.6	1.4	.....	1.4–2.1	.....	.....	....	....
	7.5	1.4	....	....	.....	1.5	.....	.....	....	....
	10.0	1.5	....	1.5	1.8	1.5–2.4	1.3–1.5	1.4	1.5	1.1
Ammonium sulphate	5.0	1.3	....	1.2	.....	1.3	.....	.....	....	....
	10.0	1.1	1.2	1.3	1.3	1.4–1.6	.....	.....	....	....
	15.0	.....	....	....	.....	1.5	.....	.....	....	....
Boric acid.....	2.5	.....	....	....	.....	1.2	.....	.....	....	....
	4.0	.....	....	....	.....	1.4	.....	.....	....	....
Calcium chloride...	10.0	.....	....	1.3	.....	1.3	.....	.....	....	....
	20.0	.....	....	....	.....	1.8	.....	.....	....	....
Phosphoric acid...	5.0	1.4	....	....	.....	.....	.....	.....	....	....
Potassium bicarbonate.	5.0	1.2	....	....	.6	.....	.....	.....	....	....
	10.0	1.4	....	....	.....	.....	.....	.....	....	....
Potassium carbonate	5.0	1.2	1.3	1.3	.....	1.0	.....	.....	....	....
	10.0	.....	....	....	.....	.....	.....	.....	....	....
Sodium acetate....	5.0	1.2	....	....	.....	.....	.....	.....	....	....
Foam not loaded[2] expelled as a liquid.	9.0	.....	....	....	.....	.....	1.2	.....	....	....
Foam loaded[2] expelled fully expanded	16.4	.....	....	....	.5–.8	.7	.7	.....	....	....
Foam loaded[2] expelled as a liquid.	16.4	.....	....	....	1.1	1.1	1.6	1.1	1.4	1.6
Foam, Special (loaded)	18.8	.....	....	....	1.2–1.5	1.3	1.3	.....	....	....

[1] Superiority factors calculated by dividing volume of water by volume of chemical solution used in totally extinguishing similar fires. Different procedures were employed in conducting tests on the different fuels so that the values shown are not entirely comparable in all cases.

[2] "Not loaded" foam contained only foam-forming chemicals; "loaded" foams contained approximately equal amounts of foam-forming chemicals and fire-retardant chemicals.



Pretreatment backfiring test in grass fuel. These pictures were taken progressively at half-minute intervals. The chemical and water-treated plots (designated by C and W, respectively), are each 2 feet wide and 40 feet long. The chemical solution was 5 per cent monoammonium phosphate.

A. Backfire hitting pretreated lines.

B. One-half minute after fire hit pretreated lines. Fire has burned through water-treated line in several places.

C. One minute after fire hit pretreated lines. Operator behind water-treated line is extinguishing the fire that burned through treated line. Operator behind chemically treated line has no fire to extinguish.

D. One and one-half minutes after fire hit pretreated lines. Operator behind water-treated line still extinguishing fire that broke through the line. Chemically treated line stopped the oncoming fire completely with no assistance from operator.

Significance.

The results of both laboratory and field tests show that the extinguishing capacity of water can be increased or reinforced materially by the addition of certain chemicals, the increase depending upon both the kind of chemical and its concentration in the solution.

The superiority of a given chemical and concentration of solution over water is not a constant but varies with a number of factors of which (*a*) the rate of application in relation to the size and severity of the fire, (*b*) the wind velocity, and (*c*) the kind and arrangement of fuel are important. Dependent upon the conditions prevailing, the amount of chemical solution required may range from approximately the same as water to only a small part of the amount of water required to extinguish a fire.

Where an abundant supply of water is available and can be used, chemicals are not considered to have any worthwhile application. Where water is scarce or difficult to get to the fire, or where the available equipment is scarcely adequate to cope with the fire, the intelligent use of chemicals can yield important advantages. In borderline cases, chemical solution may control or hold a fire where water fails, and chemicals may, in such cases, make all the difference between success and failure in an attack upon a forest fire. The use of chemicals appears most important in the early or initial stages of attack, through the use of back packs and tanks, and they probably have little if any application on large fires, unless for use when backfiring.

The value of chemicals in solution in water appears to depend in large part on the fireproofing effect on unburned material or in preventing reignition, as distinguished from a primary extinguishing effect. This fireproofing effect was clearly demonstrated in the pretreatment tests with certain chemicals.

It is realized that only a few of the many chemical materials and methods of application have been investigated and that further research in the field may yield valuable results. However, miraculous results with chemicals are not to be expected nor are chemicals equally effective under all forest fire conditions. Furthermore, to utilize present known fire-retarding and extinguishing chemicals efficiently, further studies are needed to develop or adapt apparatus and methods for their application. It is believed, however, that the work thus far points the way to a new and useful weapon for the forest fire fighter that will ultimately assist him in his never ending fight against fire.

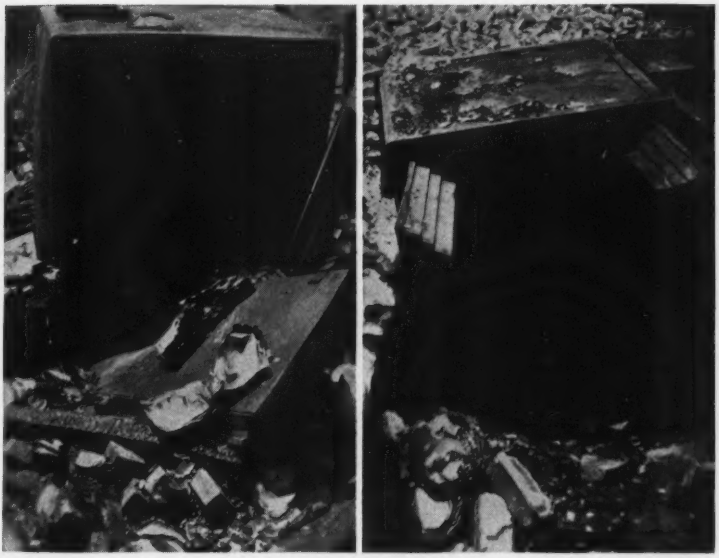
A Study of Record Container Performance.

For many years it has been realized that the destruction of vital business records by fire is a tremendous handicap, which often results in loss of business and other indirect losses in addition to the actual fire damage. Many business concerns have appreciated this fact sufficiently to provide a safe or vault in which to house their records. Unfortunately, however, in many cases the safe or vault has been of uncertain fire resistance rating or a rating inadequate to withstand the possible fire exposure in the particular property.

This subject has been intensively studied by the N.F.P.A. Committee on Protection of Records, and the official N.F.P.A. recommendations in the Consolidated Report on Protection of Records give complete data on the best methods of record protection, determination of value of records, severity of probable fire exposure, selection of safes and vaults and numerous other details. Comprehensive fire tests in this field have been made by the National Bureau of Standards, by Underwriters' Laboratories, Inc., and by members of the Safe Manufacturers National Association. Safes and vault doors bearing the label of Underwriters' Laboratories to indicate a definite performance rating are generally available. However, actual fire experience data have been meagre because of the difficulty of determining the true severity of building fires, and the reluctance of owners to give information on the loss of records which may have a serious effect on their business.

Every year many record containers pass through severe fires, but in the past comparatively few fire reports have included adequate information on record protection. As a result it has been difficult to make any statistical studies of the performance of record containers as it is done for automatic sprinklers in the April N.F.P.A. QUARTERLY each year. Up to the present time most of the information available on the performance of record containers has been obtained from tests such as those conducted by Underwriters' Laboratories, Inc., and from special studies of the results of large fires such as the report on the 1928 conflagration in Fall River, Massachusetts, and the report on the Oregon State Capitol fire, published in the July, 1935, QUARTERLY.

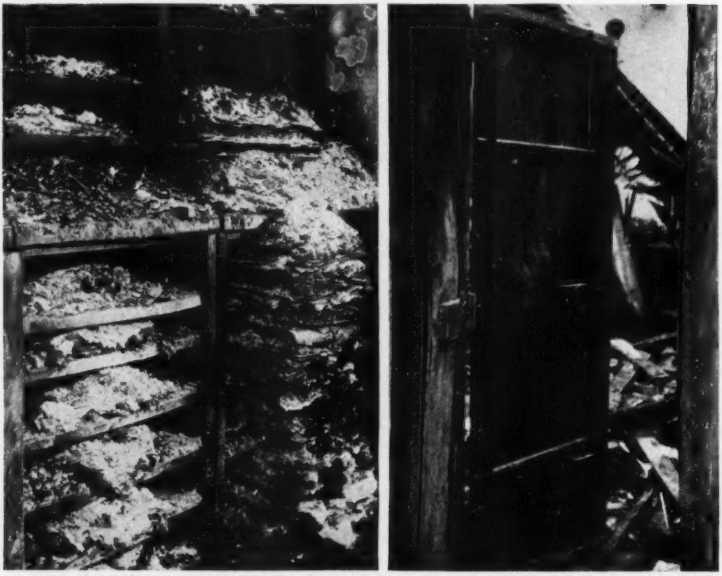
Due to the continued demand for reliable information on the performance of record containers in actual fires, the Safe Manufacturers National Association has coöperated in obtaining for the N.F.P.A. Department of Fire Record detailed reports of fires where safes, vaults and other record containers were involved. The Department of Fire Record has checked these reports against reports on the same fires furnished by insurance inspection bureaus and other member organizations. Reports including doubtful or incomplete information have been eliminated. The results obtained cover two years, 1937-1938, and



View of two of the safes which experienced severe exposure in a fire which destroyed a group of business buildings in Gainesville, Fla. The unlabeled safe shown at the left was purchased two years before the fire under the false impression that it was a two-hour rated safe. It had three-inch walls and six-inch insulated doors. The safe exploded during the fire and its contents were destroyed. The safe at the right was an old iron safe, which preserved about half of its contents in the same fire. Burned records may be seen in the foreground.

are believed to present a reasonable indication of the fire experience with record containers in the United States. The record here published includes reports on 103 containers which had sufficient details for inclusion. These included 73 safes, 20 vaults and 10 containers of miscellaneous types such as insulated letter files and cabinets. The record of safe performance has been broken down to indicate the performance of labeled safes bearing a definite performance rating, as compared with safes having no specified rating. It is interesting to note, as shown by the tables, that in no case did a labeled safe fail to preserve its contents for a period somewhat longer than its rated resistance and in no case was failure or destruction of contents complete, as it frequently was when unlabeled safes were involved.

As in other N.F.P.A. fire records covering the performance of fire protection devices, the benefit of the doubt is not given to the record containers included in this record. In every case performance was listed as unsatisfactory if scorching or other damage to contents occurred, even though the records may have been partially legible after the fire exposure.



At the left are ruins of the County Treasurer's records in the vault of the Washington County Court House at Weiser, Idaho. The uninsulated steel plate door at the right flew open and exposed the contents of the vault when struck by a hose stream which firemen were using in an effort to protect the vault.

Record protection is too vital a matter to allow borderline cases to pass as satisfactory. Where the destruction of records had begun when the fire was extinguished, the container is recorded as having failed to preserve its contents. As a matter of fact in several instances where only partial damage to the contents of old type safes and vaults was recorded, reports stated that firemen kept hose streams on the safes during the fire in an effort to prevent failure. On the other hand, where it is obvious that the safe did a good job, it has been recorded as satisfactory even if some trifling smoke and water damage occurred.

In many of the fires included in this tabulation records were lost because the occupant having the fire did not have sufficient safe or vault space in which to house vital and important records or other valuables. In most of the fires recorded, correspondence and records housed in uninsulated filing cabinets were a total loss. No attempt has been made to tabulate the extent of this damage, however, as it is well known that a comparatively moderate exposure is sufficient to destroy the contents of uninsulated files; and if owners consider records valuable they are expected to provide safe or vault protection. However, where a safe is involved it would appear that owners often expect it to provide protection regardless of the age, design or construction of the container and the probable fire severity that may be expected.

Performance of Safes.

	Labeled Safes		Obsolete or Unlabeled Safes	
	No.	Per Cent	No.	Per Cent
Contents intact	16	80.0	30	56.6
Contents damaged or destroyed	4	20.0	23	43.4

Results with Labeled Safes.

Reported Fire Duration*	Contents Preserved			Contents Damaged	
	1-Hour Rating	2-Hour Rating	4-Hour Rating	1-Hour Rating	2-Hour Rating
Under 1 hour	0	2	0	0	0
1 to 2 hours	1	1	0	0	0
2 to 4 hours	1	2	1	3	0
4 to 6 hours	0	2	0	0	0
6 to 8 hours	2	2	0	0	0
Over 8 hours	1	0	0	0	1
No data	0	1	0	0	0
Total	5	10	1	3	1

Results with Unlabeled Safes.

Reported Fire Duration*	Contents Protected	Contents Damaged
Under 1 hour	4	0
1 to 2 hours	7	2
2 to 4 hours	10	8
4 to 6 hours	4	5
6 to 8 hours	3	4
Over 8 hours	2	3
No data	0	1
Total	30	23

*Duration of fire. The fire exposure at any one point may be considerably less. The duration of the fire should not be confused with fire test ratings as measured on the standard time-temperature curve.

It is interesting to note that over half of all safe failures came with less than four hours fire exposure. This would indicate that four hour listed protection would have automatically eliminated more than one-half of the failures, as these were largely due to insufficient fire resistance of old-line safes or the use of labeled safes with only one hour rating in locations where nothing less than 2 or 4-hour protection was justified by the hazard.

Several fire reports stated that owners doubtful as to the fire resistance qualities of their safes removed the contents during early stages of the fire. Such fires have not been included in this tabulation because it is intended only to show the protection which the containers give to the contents and not the effect of the fire on the container itself.

In many cases the container appeared to be normal after the fire exposure with the exception of loss of paint. Obviously, however, despite outward appearance a safe is designed only to provide protection through one consequential fire before requiring replacement. Of course in many other cases the container, even though it preserved its contents, was damaged beyond further use.

At the left is a one-year-old labeled safe having a four-hour rating after it passed through three hours of severe fire exposure. The door was slightly warped and opened with difficulty, but the contents were preserved in perfect condition, as shown at the right.

While in some cases "reported fire duration" was recorded as greater than the rating of the label on the safe or vault door, this should not be taken as indicating that the safe or vault door provided protection exceeding its rating, because "reported fire duration" and "rating" are not not necessarily comparable, the rating on the label being a rating based on definite, controlled furnace temperatures for the time indicated, whereas, "reported fire duration" usually refers to the time that the fire was burning and is not usually an indication of the intensity of the heat at the point where the safe or vault was located nor the time that the safe or vault itself was subjected to such heat.

As the following tables indicate, many of the fires in this record were of long duration and they frequently involved total losses to the buildings in which they occurred. Once a fire has gained major headway it is frequently impossible for the average fire department to bring sufficient streams to bear to effectively reduce the duration of the fire, and in some cases the use of an inadequate number of streams may merely prolong the period of burning even if temperatures are somewhat reduced. Such factors should be considered when studying the results of this record.

Reasons for Failures of Safes.

	No. Fires
Labeled Safes	
Exposure greater than one-hour rating	3
Exposure greater than two-hour rating and careless opening	1
	4
Unlabeled Safes	
Old line safe—long exposure	6
Long exposure to severe fire	3
Insufficient wall thickness or insulation	3
Explosion in safe due to fire	3
Old cast iron safe	2
Old cast iron safe submerged in water	2
Old cast iron safe improperly repaired	1
Fell and struck by heavy débris	1
Fell and door opened	1
No data	1
	23

Extent of Damage to Contents.

	Labeled Safes	Unlabeled Safes
None or trifling	16	30
Slight to moderate (salvageable)	4	10
Considerable	0	2
Complete loss	0	11
Total	20	53

Age of Safes Involved.

	Contents Protected		Contents Damaged	
	Labeled	Not Labeled	Labeled	Not Labeled
Under 10 years	7	0	1	4
10 to 20 years	6	8	3	6
21 to 35 years	0	12	0	9
Over 35 years	0	3	0	2
Unknown—old type	0	4	0	2
Unknown	3	3	0	0
Total	16	30	4	23

It is interesting to note that none of the failures of labeled safes involved total losses. The following brief descriptions of the four cases in which the contents of labeled safes were damaged should prove interesting.

PULASKI, N. Y. A two-hour rated 7½-year-old safe was involved in a fire which burned about twelve hours and fell twelve feet. A 9-inch hole was burned through the steel covering. Hardware on the door melted off. A crowbar was used to force the door open after the fire. The contents were so hot that loose papers burst into flames when exposed to the air. Card records and books were preserved, although the book covers were charred.

AU GRES, MICH. A one-hour safe was involved in a fire of three to four hours duration and fell six feet when a frame building burned without any means of fire protection having been employed. Paper records in the safe were partly burned but distinguishable. A wooden cash drawer was charred and the

money was partly burned but redeemable. Although the contents were damaged, the safe was considered to have done an excellent job considering its one-hour rating and the severity of the fire.

DETROIT, MICH. A fifteen-year-old safe with a one-hour rating was involved in a $50,000 four-alarm fire which burned for over two hours. The fire practically destroyed a paper tube factory. Firemen used twenty-five streams and kept water on the safe continually, saving the contents, which were all smoke damaged by leaking around the door jambs and were water soaked. The owner was fortunate that the fire did not last longer, as the safe was obviously beyond its protection period.

BEMIDJI, MINN. A ten-year-old safe having a one-hour rating was subjected to severe fire exposure when the fire completely destroyed a garage containing 75 automobiles. The safe fell one story and was struck by falling débris. The lock on the safe was outside of the insulation and melted. The side wall was bellied out. When broken open the contents of the safe were found to be scorched, but were 90 per cent legible.

This 30-year-old cast iron safe preserved its contents through a fire which destroyed two manufacturing plants at Ellwood City, Pa., with $200,000 loss. While this fire burned for seven hours, the exposure to this safe was probably equivalent to little more than one hour on the standard time temperature curve.

This fifteen-year-old unlabeled safe permitted fifty per cent loss to contents when fire destroyed an automobile agency in San Bernardino, Calif. The owner was under the impression that the safe was satisfactory, but neither wall insulation nor door construction were adequate, and it failed in one and a half hours of exposure.

Performance of Vault Doors.

Twenty vaults were involved in fires reported in this record. Apparently none of these vaults were equipped with doors labeled by Underwriters' Laboratories, Inc. This study does not attempt to include details of the construction of the actual vault, but rather to indicate the effect of the doors in the preservation of the contents. All of the vault doors involved were of either uninsulated steel or cast iron construction and there is no indication in any instance of failure having occurred due to transmission of heat through the vault walls before the doors failed. It will be noted from the tables that the contents were preserved intact in only 50 per cent of the fires involving vaults.

The one-hour labeled safe shown at the left of the filing cabinets preserved its contents through a severe fire which destroyed two mercantile buildings. The safe was partly covered with hot débris and hose streams were played upon it for three hours. All records were in good condition, but were slightly damaged by water.

Three interesting fires involving vaults warrant special mention as follows:

KANSAS CITY, MO. Fire destroyed a garage, causing the destruction of all vital records of the business. These records were housed in an uninsulated sheet steel storage cabinet which the owner believed to be fireproof. The building was equipped with a record vault which was only used to store stationery and which preserved its contents. The owner, impressed by an unscrupulous local dealer, placed great faith in the storage cabinet in spite of the fact that it was uninsulated.

WEISER, IDAHO. Fire destroyed the Washington County Court House and the entire contents of the County Treasurer's vault were lost when the doors flew open when struck by a hose stream. The vault doors were believed to have been locked at the time of the fire. Losses in the vault besides important records included about $5000 in uninsured cash and checks.

SWAINSBORO, GA. Three small vaults containing county records were involved in a fire which destroyed the Emanuel County Court House. The vaults had one-half inch plate type doors, which were closed during the fire. The doors did not fit tightly. The fire department played hose streams directly on the vault doors in a successful attempt to prevent the complete destruction of the contents. A large amount of water was forced under and around the doors into the vaults. This water was turned to steam by the severe heat around the vaults and caused severe damage to all the contents of the vaults. Some fire damage had also occurred in the vaults before the water was applied.

This twenty-five-year-old cast iron safe failed in a one-hour exposure at Vancouver, Wash. Fortunately the owner was able to reach the safe in the early stages of the fire and remove the most vital contents. The remainder were destroyed.

Performance of Vault Doors.

(Doors not labeled.)

	Single Door		Double Door		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
Contents intact	6	42.9	4	66.6	10	50.0
Slight to moderate damage	6	42.9	1	16.7	7	35.0
Contents destroyed	2	14.2	1	16.7	3	15.0
Total	14	100.0	6	100.0	20	100.0

Results with Vault Doors.

	Single Doors		Double Doors	
Reported Fire Duration*	Contents Protected	Contents Damaged	Contents Protected	Contents Damaged
Under 1 hour	0	1	0	0
1 to 2 hours	0	0	0	0
2 to 4 hours	4	2	1	1
4 to 6 hours	0	3	1	1
6 to 8 hours	1	2	2	0
Over 8 hours	1	0	0	0
Total	6	8	4	2

*Duration of fire. The fire exposure at any one point may be considerably less. The duration of the fire should not be confused with fire test ratings as measured on the standard time-temperature curve.

Reasons for Failure of Vault Doors.

	No. of Fires
Steam due to water from protecting streams entering vault	3
Door flew open when struck by protecting hose stream	1
Uninsulated single doors inadequate for long exposure	3
Cast-iron single doors inadequate for exposure	1
Uninsulated single doors allowed damage in short exposure	1
Uninsulated double doors inadequate for severe exposure	1

Types of Vault Doors Involved.

	Contents Intact	Contents Damaged
Uninsulated single doors	4	7
Uninsulated double doors	3	2
Cast iron single doors	2	1
Cast iron double doors	1	0
Total	10	10

Miscellaneous Containers.

In addition to the reports covering the performance of safes and vault doors, reports were received of the performance of ten other record containers of various types. These included five insulated letter files, three storage cabinets and two listed as miscellaneous containers. While the number of fires in this group is not great enough to permit tabulation, the limited data indicate generally satisfactory performance of these insulated containers under moderate fire exposure.

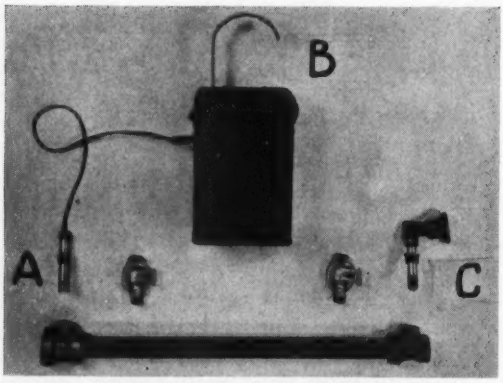
The "Pipescope."

By Gordon F. Price,
South-Eastern Underwriters Association (Member N.F.P.A.).

Foreign materials, such as sand, gravel, rock, cinders, clay and accumulations of rust and corrosion, sometimes cause trouble in sprinkler systems, particularly in older systems where at some previous time the water supply has not been given adequate attention. This matter is of great interest to inspection departments and is becoming of increasing concern with the increasing age of systems. Inspection departments wishing to ascertain positively that sprinkler systems are in proper operative condition must assure themselves that piping is free from any obstruction that might interfere with full flow of water through the pipes. The usual flow tests are of value in detecting any major obstructions to water supplies, but are not a practical method of determining the condition of branch lines and do not always indicate the condition of risers and bulk mains which sometimes have partial obstructions which would permit flows of water of the amount usual for test purposes, but which might cause serious trouble in case of fire where a large number of sprinkler heads open and the full capacity of the pipe is needed. While experience indicates that trouble from stoppage exists in certain cases, there are no data to show that this subject should be alarming from a general viewpoint.

If there is any suspicion as to the condition of the interior of sprinkler piping, it is the general practice of inspection departments to make a systematic investigation to determine whether any such trouble exists and the nature of the obstructions. Accurate information is necessary in order to determine the nature of cleaning operations or other corrective measures to be taken. Any internal examination of sprinkler piping means taking the system out of service with consequent temporary interruption of sprinkler protection. When such work is stopped overnight, disconnected piping is plugged so that the balance of the system may be kept in operation and special watchman service provided or other appropriate measures are taken to minimize the hazard of fire. During any examination of sprinkler piping, which causes temporary impairment of sprinkler protection, it is important, of course, that the same general practices be followed as in doing any work on a sprinkler system — that is, the work should be conducted only by qualified persons, being so planned that water can be quickly turned on in case of fire, and the system never left unattended during the time of impairment.

The usual method employed in testing for stoppage is to actually remove for visual examination certain sections of pipe considered to be located at vul-



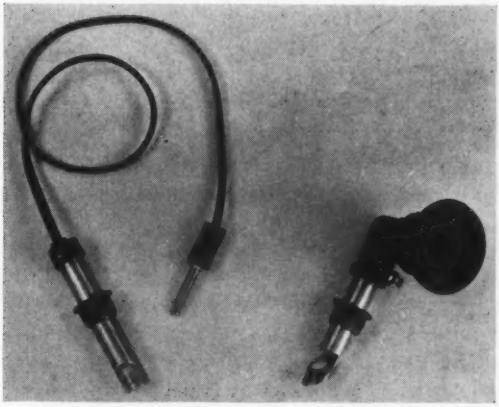
The "Pipescope" consists of a metal combination carrying case and battery box "B," a light source "A," and a periscope "C."

nerable points in the system. This method, though a logical one, involves certain undesirable features, for in old systems particularly, it is likely that some leaks and broken fittings may result from breaking into the system, with possibility of water damage, especially if the work is done by other than those experienced in pipe fitting; also, considerable time and labor are involved and proper tools required.

In order to overcome, at least to a great extent, some of the undesirable features encountered in this examination work and to save time and assist in the operation, an instrument known as a Pipescope has been developed and used by the South-Eastern Underwriters Association with what are considered very practical results.

The instrument consists essentially of a metal combination carrying case and battery box "B," a light source "A," and a periscope "C." The carrying case accommodates a battery wired to a switch and jack mounted on side of the case, and has an open side handle on top for carrying the equipment and for hanging the case on a sprinkler line when the instrument is in use. The entire apparatus weighs approximately seven pounds, including the battery, and is easily portable.

The light source "A" is composed of a small electric lamp properly mounted in a metal tube of such size that the tube can be inserted in the standard size pipe fitting which accommodates an automatic sprinkler head. The end of the tube containing the lamp has two holes diametrically opposite each other and which are fitted with a special light diffusing material. The type lamp and degree of diffusion used were determined by definite experiments run to obtain the best illumination for pipe interiors, resulting in a light of sufficient quantity but of controlled intensity to prevent glare. The arrange-



Detail view of the light source (left) and the periscope.

ment is such that when the tube is inserted in a pipe fitting where a sprinkler head has been removed there is a beam of light directed from the lamp through the holes in the tube, which will illuminate the pipe of the sprinkler system in both directions from the fitting. The tube containing the lamp further has an adjustable device on it which limits the distance the tube is inserted into the fitting so that the lamp holes will come into a position in the center of the pipe extending from the fitting. The light source is supplied with electricity through a small cable that plugs into the battery box which can be hung on the sprinkler pipe near the fitting. The battery, which is composed of two No. 6 dry cells, will operate the special lamp used for approximately 150 hours before renewal is necessary.

The periscope "C" is also designed so that it can be inserted in a pipe fitting from which a sprinkler head has been removed and thus permit the observer to look in the pipe toward another fitting along the pipe into which the light source has been inserted and in this way observe the internal condition of the pipe located between the light source and the periscope. The periscope is further designed so that the lower part can be revolved 180 degrees relative to the head piece in order that the observer can look in either direction in a pipe without having to change his position relative to the pipe fitting. The apparatus works in any size pipe encountered in sprinkler systems.

With aid of the Pipescope it is possible for one operator to make internal examination of the branch line piping of a sprinkler system with no additional equipment except for ladder and sprinkler head wrench. It is not necessary to dismantle any of the pipe proper, which eliminates the disadvantages previously mentioned in this connection. In using the Pipescope the only joints broken are those involved in removing and replacing sprinkler heads and as these parts

are non-ferrous metal little trouble is ever encountered in this operation and the possibility of leakage after replacement is a minimum.

The Pipescope is effective in examining those parts of a sprinkler system where entry can be made by removing heads or by any other means that might be available. This will therefore ordinarily limit the use of the instrument to examination of the sprinkler branch lines, but it must be borne in mind that the branch lines constitute the major portion of a system and any stoppage existing in a system will, with little or no exception, be evidenced in the branch line piping. In the case of nippled pendant heads on a branch line (which constitutes a very small percentage of the installations) the Pipescope is not effective, but in such cases it is believed that the pockets formed by such nipples will be the first places in the pipe where stoppage will ordinarily collect and by the removal of these heads and direct examination of the nipples the condition existing can be revealed. Other occasional special sprinkler installation methods may prevent use of the instrument, but these usually are the exception rather than the rule and it is generally found that the apparatus is serviceable on all of the branch line portions of a system. Also, if crooked pipe is encountered, examination of other pipe sections in the immediate vicinity should give sufficient indication of the conditions inside the system.

In actual use the Pipescope gives the observer a view of the pipe interior sufficiently clear for a detailed examination of the pipe wall when the light source and periscope are applied at points of adjacent sprinkler heads on a line. The instrument is also effective for a distance between several heads on a line if the pipe is straight, but due to diminishing pipe size at most fittings on a branch line, this method will show whether the line is open, but does not afford opportunity for detailed examination of the pipe wall throughout the length of pipe under observation. In examining long sections of pipe where there is no change in size the instrument is effective for several pipe sections and gives a good view of the wall condition throughout.

In the case of bulk and cross mains there is usually no ready means to insert the instruments and therefore if it is desired to examine the large pipe in a system it is necessary to resort to dismantling the pipe. Even so, however, the Pipescope will be of assistance, for with the instrument it is necessary to remove only sufficient pipe to gain entry to the large pipe to be examined, as for example by backing-out a limited number of the connecting pipes, but it will not be required to dismember as much pipe as would ordinarily be necessary without the instrument. Were it possible to provide one-half inch plugs at proper intervals in fittings of the bulk pipe when a system is installed, the Pipescope would offer a means of examining the entire system of practically any installation for stoppage merely by removing sprinkler heads and the plugs installed in the bulk pipe.

Carbon Dioxide Fire Tests.

As a result of fires in government office and record storage occupancies in Washington, consideration has been given by the Federal Fire Council* to the possibility of using carbon dioxide for extinguishing fires in such occupancies, particularly in enclosed spaces where the smothering effect of the gas could be most effectively utilized. Previous experience with carbon dioxide has been largely in the protection of special hazards, including highly combustible occupancies handling flammable liquids. While the N.F.P.A. Committee on Manufacturing Hazards in the Regulations for Carbon Dioxide Fire Extinguishing Systems has indicated the suitability of carbon dioxide protection for vaults, libraries and other places where fires may be extinguished with carbon dioxide with less loss than if water is used, practical experience with such use of carbon dioxide, particularly on any large scale, has been limited. In order to secure data on this subject, a series of large-scale tests with the use of carbon dioxide for extinguishing fires in office and record storage occupancies, undertaken under the auspices of the Federal Fire Council, was completed last summer. These tests, under the direction of S. H. Ingberg (member N.F.P.A.) of the National Bureau of Standards, with the coöperation of various other agencies, were conducted in part in a test building of the Bureau of Standards and in part in a larger building in downtown Washington. The following account has been abstracted from the complete report submitted to the Federal Fire Council. The observations and conclusions given are those of the original report. Because of lack of space further comments, a large part of the detailed test data, and general information on the properties of carbon dioxide have been omitted.

Preliminary Tests.

Tests I, II, and III were conducted in a one-story building having brick walls and a concrete roof, the general plan of which is shown in Fig. 1. The net volume of the building outside the cubicles was about 3600 cu. ft. The test fires were located in the northeast and southeast corners of the building. The extinguishing gas was discharged near the center of the room.

The gas was received in 50-lb. cylinders, up to eight of them being connected with a manifold to which was attached 50 ft. of hose with attached discharge horn.

Temperatures were determined by thermocouples at two levels near the fires. The carbon dioxide concentrations were measured with a thermal conductivity type indicator, the gas being sampled at a point about 4 ft. above the

*For an account of the functions and activities of the Federal Fire Council, see Proceedings, 1938, page 298.

Table I. Summary of Results.

Test No.	Room Area Sq. Ft.	Room Volume Cu. Ft.	Contents	Gas Discharge: Time After Start of Test (Min.)	Gas Discharge: Duration (Liquid) (Sec.)	Gas Discharge: Amount Total (Lb.)	Gas Discharge: Amount Room Volume per Lb. (Cu. Ft.)	Maximum Gas Concentrations: Computed CO_2 (Per Cent)	Maximum Gas Concentrations: Computed O (Per Cent)	Maximum Gas Concentrations: Indicated CO_2 (Per Cent)	Temperatures*: Before Discharge °F	Temperatures*: After Discharge °F	Extinguishment With the Gas	Remarks
I.	360	3600	Wood and paper..	1⅓	180	199	18.1	39	12.8	47	250	100	Complete.	Conditions represented automatic CO_2 discharge.
II.	360	3600	Paper in metal shelving and cabinets	60	...	405	8.90	65	7.4	67	490	110	Complete except for glow in paper.	Glow extinguished with 8 gallons water.
III.	360	3600	Wood and paper..	12	...	404	8.92	64	7.5	62	1290	130	Complete except for glow in one spot.	Glow extinguished with ½ pint water.
IV.	2440	43000	Wood and paper. Wood and metal shelving	3¼	120	2460	17.5	41.5	12.3	..	210	20	Complete.	Conditions represented automatic CO_2 discharge.
V.	2440	43000	Wood and paper. Wood and metal shelving	16¼	210	3650	11.8	53.3	9.8	50	260	90	Complete.	
VI.	717	9320	Wood and paper.. Wood shelving....	14¼ 36½ to 80½	80 75 to 90	786 3050	11.8 ...	53.3 ...	9.8 ...	39 ..	1480 1550 1190 600	700 500 350 180	Fire rekindled at 5 to 35 min. after each discharge. Nearly out at 1 hr. 40 min. to 1 hr. 55 min.	Rapid ventilation through basement openings and elevator shaft. Fire extinguished with hose stream at 2 hr. 10 min. to 2 hr. 20 min.
VII.	225	2700	Wood and paper.. Wood shelving....	46 47½ to 69	35 6 to 21	430 870	6.3 ...	76 ...	5 ...	.. ..	510 ...	115 ...	Initial discharge extinguished fire except for glow in débris. Later discharges extinguished glow except at one spot.	Subsequent blaze rekindled from glow extinguished with less than 1 gallon water.
VIII.	5000	87400	Wood, paper..... Also oil in pans and flares	12⅛ 28½	450 ...	5550 600	15.7 ...	43.6 ...	11.8 ...	34 ..	430 ...	60 ...	Oil fires extinguished. Fires in wood and paper rekindled.	Fire extinguished with hose stream at 55 min. to 1 hr. 35 min.
IX.	2440	43000	Wood and paper. Wood and metal shelving	13⅓	260	5130	8.4	65.8	7.2	63	350	100	Complete.	
X.	2440	43000	Wood and paper. Wood and metal shelving	12¼	...	2550	16.8	41.5	12.3	39	580	140	Fire rekindled after room was ventilated.	Rekindled fire allowed to burn without extinguishment until building collapsed.

*These are the highest average temperatures before gas application recorded for the room or portion of the room in which the fire was started and the lowest average after gas application before the room was ventilated. In the case of Tests I and IV they apply for the ceiling level only. They indicate to some extent the intensity of the fires before gas was applied and the subsequent degree of cooling. The low average room temperatures obtaining before gas application in some of the tests, despite the active combustion, can be attributed to the large room volumes.

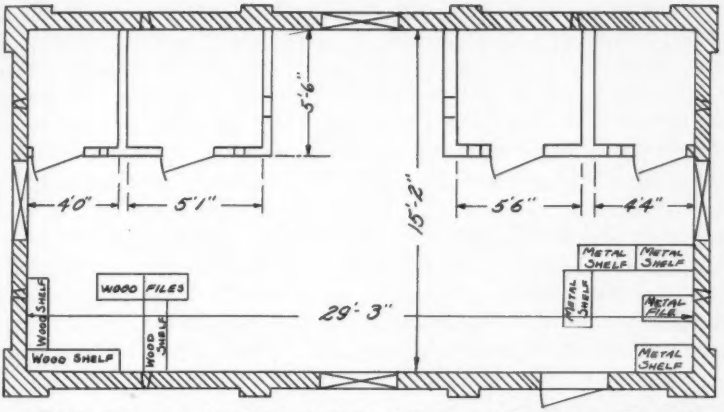


Fig. 1. Plan of test building at National Bureau of Standards. The ceiling height is 10 ft.

floor, near the center of the building. Room volumes, temperatures, carbon dioxide concentrations, and other pertinent data are given in Table 1.

Test I was intended to simulate conditions under which the carbon dioxide gas is released by the operation of an automatic fire detector. Open wood shelves and wood filing cases were loaded with 1576 lbs. of paper and the fire started in 25 lbs. of loose paper on the floor. A fire detector mounted on the ceiling operated a minute and a half after the start of the fire. Thirteen seconds later gas was discharged from four cylinders, most of the discharge occurring within three minutes. No glow or flame was found in any of the papers after the room had been opened and ventilated. No water was applied. The papers on the shelves above the pile in which the fire was started were charred on the edges, but were almost all legible.

In Test II steel shelving with solid backs and sides and a steel filing case were loaded with 1738 lbs. of paper and the fire started in 50 lbs. of loose paper on the floor. It was necessary to stir the papers on the floor occasionally so that they would continue to flame. Gas was not discharged until the fire had been in progress for one hour. Eight cylinders were opened within 30 seconds and most of the discharge was completed in 15 minutes. The door was opened at 1 hr. 29 min., and at 1 hr. 35 min. fire was noted in the débris on the floor and in one of the shelves. Four minutes later the fire was completely extinguished by the application of eight gallons of water. The papers in the filing cabinet were browned and charred to a depth of less than 1 in. The papers on the bottom shelf were burned completely in some places and on other shelves were charred to depth from ½ to ¾ in. The papers on the upper shelves were browned and charred on the edges only.

Test III was conducted in the same location and with the same equipment as Test I; however, the fire was allowed to burn for 12 minutes before the gas was discharged. Eight cylinders were opened at 2½ second intervals and most of the discharge was completed within 5 minutes. At 47 minutes, after the room had been ventilated, no glow or flame was found. At 2 hours a small amount of glow was found in papers on a collapsed shelf and was extinguished with about half a pint of water. No further fire was noted. During the test the wood shelves had collapsed and papers had been burned or charred to depths up to 1 in. In one wood filing cabinet the papers were undamaged and in another the fire had entered one drawer and charred the papers near the front.

In all three tests the gas applied was effective in extinguishing flame and also glow to such an extent that there was no active combustion immediately after the room was ventilated. Where flame or glow was found after the building had been open for some time the fires were extinguished with relatively small amounts of water.

Tests in Firestone Building.

While the results of the preliminary tests give important information on concentrations of carbon dioxide needed for extinguishment, many conditions could not be introduced that would be present in fires in larger buildings. Through the coöperation of the Public Buildings Administration of the Federal Works Agency, arrangements were made for conducting tests in the Firestone Building, a building which was to be razed on the site of a proposed government building in Washington, D. C. The building, except the roof, was of fire-resistive construction, with protected structural steel members and reinforced concrete floors (Fig. 2). The areas and volumes of the west and middle rooms on the ground floor are fully representative of the average, if not the maximum size, of enclosure that would be encountered in buildings occupied for office and record storage purposes.

Most of the lumber used for loading the building was from the interior of old buildings being wrecked on the site, although some of the material was concrete form lumber which was dried within the building for about two weeks before the tests. The paper used was discarded government records that had been in storage for years. The outside temperatures during the tests ranged from 69 to 87° F., and the relative humidity was from 57 to 37 per cent.

The gas for extinguishment was supplied from service or transport trucks and was refrigerated to about 0° F. to reduce the pressure in the containers. The low temperature is maintained either by refrigerating coils in the container or by automatic release of gas at the top of the container, the consequent evaporation of an equal weight of liquid resulting in a drop in temperature. The total amount of gas used for the tests was about 25,000 lbs., supplied from one 3½-ton container and two 8-ton containers. The 3½-ton container was mounted on a motor truck and the 8-ton containers on trailers.

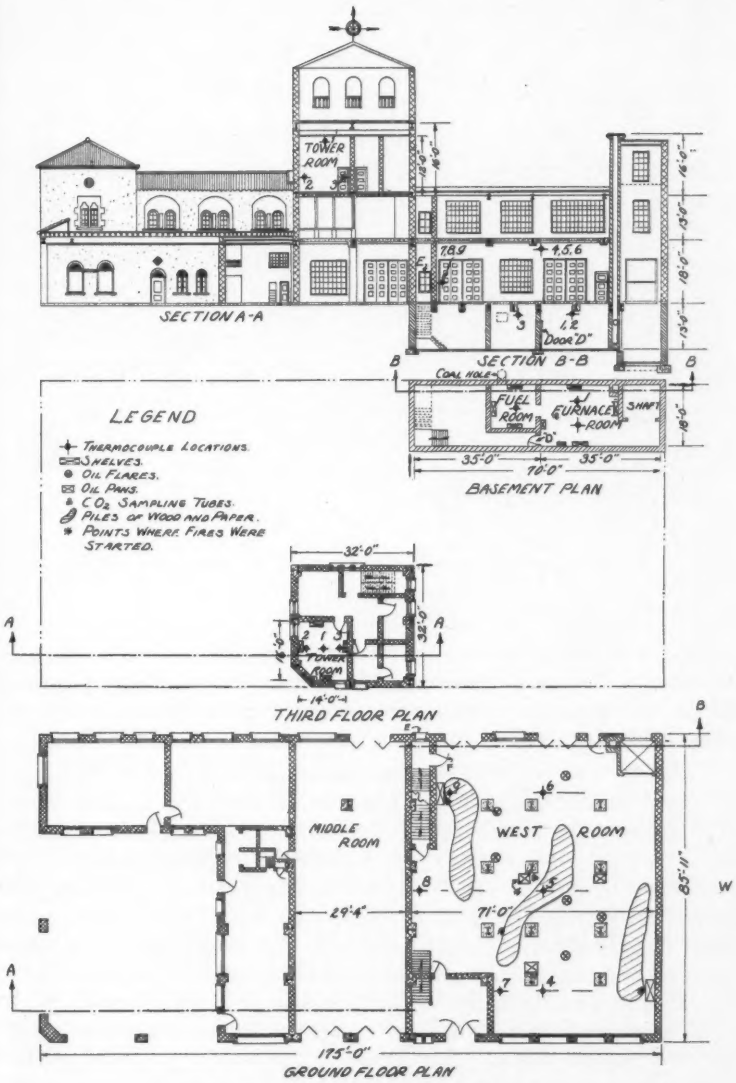


Fig. 2. Plan of Firestone Building.

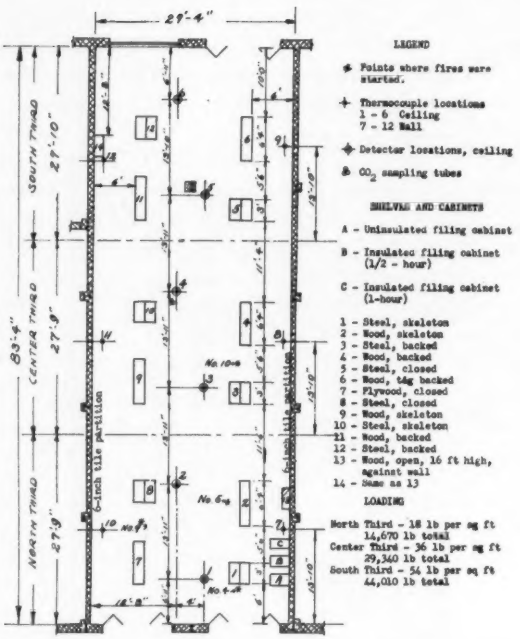

29'-4"
83'-6"
SOUTH THIRD
CENTER THIRD
NORTH THIRD
27'-10"
27'-9"
27'-9"
6-inch tile partition
LEGEND
Points where fires were started.
Thermocouple locations
1 - 6 Ceiling
7 - 12 Wall
Detector locations, ceiling
CO_2 sampling tubes
SHELVES AND CABINETS
A - Uninsulated filing cabinet
B - Insulated filing cabinet (1/2 - hour)
C - Insulated filing cabinet (1-hour)
1 - Steel, skeleton
2 - Wood, skeleton
3 - Steel, backed
4 - Wood, backed
5 - Steel, closed
6 - Wood, b&g backed
7 - Plywood, closed
8 - Steel, closed
9 - Wood, skeleton
10 - Steel, skeleton
11 - Wood, backed
12 - Steel, backed
13 - Wood, open, 16 ft high, against wall
14 - Same as 13
LOADING
North Third - 18 lb per sq ft 14,670 lb total
Center Third - 36 lb per sq ft 29,340 lb total
South Third - 54 lb per sq ft 44,010 lb total

Fig. 3. Plan of middle room, Firestone Building.

For most of the tests the gas was discharged through 150 ft. of 1½-in. metal-reinforced hose. The nozzle used had four outlets discharging against a central baffle in a 7-in. diameter head. No stoppage from freezing in the discharge equipment occurred during any of the tests.

Fires in Middle Room.

Tests IV, V, IX, and X were conducted in the middle room on the first floor (Fig. 3). The volume of the room was 43,000 cu. ft., the average ceiling height being 17½ ft. Records were placed on metal and wood shelving of various types. The combustible contents, including the wood and paper piled on the floor, averaged 18, 36, and 54 lbs. per sq. ft. for the north, middle, and south thirds of the room, respectively. Near the north or front door against the west wall were placed one uninsulated filing cabinet, a one-half hour insulated cabinet, and a one-hour insulated cabinet.

Temperatures were determined by thermocouples near the ceiling and along the east and west walls of the room. Carbon dioxide concentrations were measured with a thermal conductivity type indicator, which drew samples from three levels near the center of the room. Six bimetallic fire detectors were mounted on the ceiling along the north to south center line.

Fig. 4. Portion of middle room after fire was allowed to burn for fifteen minutes and then completely extinguished by carbon dioxide. Papers in insulated filing cabinets were undamaged. Some papers in an uninsulated file were scorched. Contents of open shelving were charred.

Test IV was intended, as in the case of Test I, to simulate conditions of automatic release of carbon dioxide gas. The fire was started in paper between the skeleton steel shelf (No. 1 in Fig. 3) and the north door of the room. All doors and windows were closed during the fire and the gas application. The signal from the automatic alarm equipment was received at 2 min. 50 sec. after the fire was started. Carbon dioxide discharge into the room was begun at front and rear about one minute after the alarm sounded. At 4½ min. the alarm bell ceased ringing, an indication that the temperature near the ceiling was below 135° F., the operating point of the detector. The discharge of gas was continued for a total of two minutes. At about 19 min. the front and rear doors were opened and the fire was found to be completely extinguished. The paper in the steel shelving near the starting point of the fire was but slightly charred. The results were much the same as in Test I.

In Test V the fire was started near the east side of an open-type wood shelf (No. 2 in Fig. 3). Application of the gas was delayed until 15¾ min., when discharge into the front was begun, discharge into the rear being started 1 min. later. The discharge lasted for 2¼ min. in front and 3¾ min. in the rear. While doors and windows had been partly opened at times preceding

release of the gas, the only opening after the discharge was a 16 by 16 in. panel which had been removed in order to insert the nozzle. At 55 min., when the front and rear doors were opened, the room atmosphere appeared to be fairly clear. There was considerable charring of the contents of both the wood and metal shelves and also charring to the top of a 16-ft. high wood shelf. The fire had extended on top of the wood piled in the center aisle nearly to the middle of the room. At the bottom of the pile it had not traveled far from the starting point. While the contents of the insulated filing cabinets had not been affected, two file folders in the front of the uninsulated cabinet had been scorched. Complete extinguishment of all flame and glow had been obtained by use of the gas.

In Test IX the fire was started between closed plywood and metal cabinets (Nos. 7 and 8, Fig. 3). The wood cabinet was flaming in less than 2 min., and at 10 min. it was noted that the back of this cabinet had burned off. At 12⅓ min. gas discharge was started at the front of the room and in the rear at 14⅓ min. and continued for about 5 min. and 3 min., respectively. Canvas was used to cover the openings around the discharge pipes to decrease the amount of air drawn in with the gas. The doors were opened at about 45 min., and at 57 min. the room atmosphere was clear. The fire had spread from its starting point 6 ft. southward, almost to the east wall, and to within 3 ft. of the west and north walls. The double thick ¼-in. plywood backs and doors of the wood cabinet had been consumed. The records inside had been charred in varying amounts, and it was estimated that from 15 to 30% were illegible. It was also estimated that charring had rendered no more than 2% of the papers in the metal cabinet illegible. The fire was extinguished by the gas.

The object of Test X was to determine the degree to which a fire can be checked by the application of gas in insufficient amount to produce complete extinguishment, but sufficient to stop flaming and make it possible to ventilate the room without danger of immediate rekindling of the fire. The fire was started between metal cabinets and wood backed and partitioned cabinets (Nos. 3 and 4, Fig. 3). The fire progressed rapidly, spreading nearly the full width of the room in 5 min. Application of gas was begun from the rear at 12 min. and from the front ½ min. later. Discharge continued for about 12 min., residual gas from the truck being used. Firemen who entered the room at 31 min. reported that they had found no fire. The doors were opened at 50 min., at which time the smoke inside was still dense. At 53 min. the fire rekindled near the point where it had been started. The remaining portion of this test is of interest as giving information on the intensity of fires in building contents and will be described in a later section. The time-temperature and carbon dioxide concentration curves for the north third of the room are given in Fig. 7.

Fig 5. Basement furnace room before Test No. VI. Scrap wood and paper were used in these tests to represent the combustible contents in office and record storage occupancies.

Fire in Basement Room.

The dimensions of the basement room in which Test VI was conducted are shown in Fig. 2. The fuel and furnace rooms were loaded with 14,700 lbs. of wood and paper, 25 lbs. per sq. ft. of floor area. Another basement room connected with the furnace room at door "D" (Fig. 2) was not loaded. Temperatures were measured with ceiling thermocouples only, and carbon dioxide samples were taken from a point near the doorway between the loaded rooms.

The fire, which started at the east end of the furnace room, progressed rapidly. Door "D," window "E," the chimney, and the elevator shaft were open, thus creating an appreciable draft. When the fire had been burning about 15 min., 786 lbs. of gas, equivalent to 53% concentration, was discharged into the fuel room through the coal hole. The concentration which at 6 ft. above the floor was measured as 39%, dropped rapidly because of the ventilation and the fire rekindled. More gas was discharged at 36½ min., and still more at 51 min. An attempt was made to close off the elevator shaft at the ground floor level, and additional gas was discharged at 1 hr. Although the indicated concentration was over 60% and remained fairly high for about 15 min., the fire again rekindled. More gas was discharged with little effect. The fire was finally extinguished with water from a 1-in. nozzle.

Fire in Tower Room.

Test VII was conducted in the tower room, the location and dimensions of which are shown in Fig. 2. The wood and paper in this room weighed about 21 lbs. per sq. ft. Temperatures were measured by thermocouples in the walls and near the ceiling. The carbon dioxide concentration was not determined.

The fire was started near the door and allowed to burn for 46 minutes before gas was applied. During this period the door and one window were opened for a short time to encourage flaming. The gas was applied intermittently through the east window up to 54 min. At 57 min. the door was opened and the débris raked with a fireman's hook. No glow could be seen from this point. The discharge nozzle was then shifted to the door, where a hole had burned through, and brief applications were directed into the pile of burned material at intervals of about 3 min. until all fire and glow were apparently extinguished. However, after the carbon dioxide hose had been removed, a small blaze was extinguished with a 5-sec. application of water from a ⅛-in. nozzle. No flames had come in contact with the window panes, and though cracked by the heat they had remained in place.

Fire in West Room.

The west room, Fig. 2, the net volume of which was 87,400 cu. ft., was used for Test VIII. Two open wood shelves 3 ft. wide and 16 ft. high were placed against the east and west walls. These were filled with paper so arranged as to facilitate rapid vertical spread of the fire. Around the base of these shelves and extending over a considerable area were piles of lumber and paper, and another pile of paper and lumber was in the central portion of the room. On the floor were two metal pans and a 1-gal. can containing kerosene. Six oil flares were suspended at two levels. Thermocouples were located near the ceiling and along the east wall. Carbon dioxide samples were taken as mixtures from three levels near the center of the room.

Fires were started in the paper and wood at the bases of the shelves and also near the center of the room, and in the oil and flares. At 2½ min. fire had progressed to the top of the shelves. Depletion of the oxygen supply then caused a decrease in the intensity of the fire for a while until the doors were opened. At 12 min. the doors were closed, and 10 sec. later gas application was begun through the transom of a window in the north wall. The opening through which the nozzle was inserted was about 6 sq. ft., and no doubt admitted a considerable volume of air. This gas discharge continued for 7½ min., and at 28½ min. some residual gas in the tank was discharged. Firemen, who had entered with oxygen masks at 42 min., reported finding no glow or flame, but subsequent to the opening of the doors at 52½ min. the fire rekindled. Water was then applied to extinguish the fire.

Fig. 6. Front of the Firestone Building during Test No. X.

Unchecked Fire in Middle Room.

When the fire rekindled at 53 min. in Test X no effort was made to extinguish it. At 56 min. the rear doors of the room were opened as well as two doors in the front. Flames had reached the ceiling near the west wall at 60 min. At 1 hr. 8 min., or 15 min. after the rekindling, flames were sweeping against the west wall and along the ceiling halfway to the east wall. It was noted at 1 hr. 10 min. that the 6-in. tile partition on the east had deflected toward the fire about 2 in., but no spalling of tile shells was noted. At 1 hr. 12 min. a half square foot hole had been broken in the 6-in. tile partition on the west near the rear column of the tower. At 1 hr. 14 min. flames out of the front door opening were reaching the second floor level. By 1 hr. 24 min. considerable smoke was issuing from the rear doors, although most of the active combustion was still localized in the front half of the room.

The closed metal shelves in the northeast portion of the room were still standing at 1 hr. 35 min. Flames were issuing from the uninsulated filing cabinet at the front of the room, but none from the insulated cabinets. Flames out of the rear door reached the second floor level at 1 hr. 39 min. At 1 hr. 58 min. more tile fell from the west wall near the rear tower column. At 2 hrs. 10 min., there was an increase in the volume of flame coming out at the front. More of the west partition had fallen, leaving an opening about 10 by 12 ft.

Fig. 8. The Firestone Building after the collapse of the tower.

near the stairs. At 2 hrs. 13 min. the front portion of the east partition fell. At 2 hrs. 14 min., or 1 hr. 21 min. after the rekindling of the fire, the entire tower section of the building collapsed toward the rear, wrecking the structural framing of the middle section and portions of the floor and roof framing of the sections on each side. This collapse resulted from the failure of the 10 by 10 in., 60½ lb., H columns supporting the rear corners of the tower, from which part of the 3-in. clay tile protections had fallen when the partitions fell. Fig. 8 is a view of the front of the building after the collapse. From this time on, efforts were concentrated on confining the fire to the collapsed portion of the building.

The 100-ton load on the column which collapsed caused a stress of approximately 11,300 lbs. per sq. in. The unsupported length of the column from first to second floor was 18 ft. The performance of this column was comparable with that of similarly protected columns as reported in "Fire Tests of Building Columns."*

For comparison the standard reference curve applied for controlling the intensity of the fire exposure in fire tests of building constructions is given in Fig. 7. It is noted that in the north third the temperature rose somewhat more rapidly than is indicated by the standard curve and reached maximums of 1800 to 2000° F. within ½ hr. after the fire had rekindled. These high tem-

*Published by the National Bureau of Standards and by Underwriters' Laboratories.

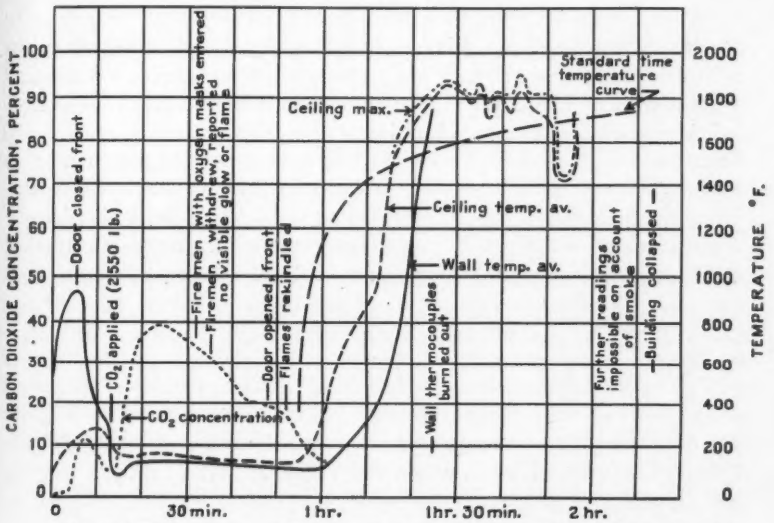


Fig. 7. Temperature readings and carbon dioxide concentrations in Test No. X. These were recorded in the north third of the room, where the conditions were in general most severe. There is evidence from readings in the middle third that temperatures of over 2000° F. were reached at some points. The combustible contents of this area, equal to 18 lbs. per sq. ft., were about two-thirds consumed when the building collapsed.

peratures were maintained for nearly 30 min. Subsequently, the temperatures in the north third were somewhat lower, but because of smoke at the observation post, temperature readings could not be taken after 1 hr. 56 min. It is estimated that about 2/3 of the combustibles in the north third of the room were consumed. The fire had not progressed appreciably into the large accumulation of wood and paper in the rear third.

The uninsulated filing cabinet at the front of the room was badly damaged and its contents destroyed. The papers in the one-half hour cabinet were fully legible except about 5% of those in the top drawer, and all the papers in the one-hour cabinet were legible, although the edges of a few were charred. The results indicate that considerable protection is afforded by the insulated cabinets, although due to their location near the door, they were not subjected to the full severity of the fire exposure indicated by the temperature curves for the given section of the building.

Summary and Conclusion.

The results of Tests Nos. I and IV, Table 1, indicate that with automatic application of carbon dioxide, concentrations of not more than 40%, or 1 lb. of gas per 18 cu. ft. of room volume, are required.

When the gas is applied by a public fire department some delay must be expected. The 12 to 16 min. delay in Tests Nos. III, V, and IX may be representative, and in one of which (Test V), complete extinguishment was obtained by gas equivalent to 1 lb. per 11.8 cu. ft. of room volume, a computed concentration of 53.3%, where no decided influx of air was present. For delays of 45 min. to 1 hr. (Tests Nos. II and VII), where closely packed papers or heavy wood members were involved, extinguishment of the fire was not complete. However, the remaining glow or smouldering was extinguished by local applications of water, with little damage to surrounding contents or construction. In Test VII it is possible that complete extinguishment would have been effected by the initial gas application had ventilation of the room been delayed for a longer time. The same may be true as concerns Tests Nos. II and III.

The conditions purposely introduced and results achieved in Test VI emphasize the need for guarding against decided drafts. It would have been a simple matter to have arranged this test so that extinguishment would have been complete, since basements, as a type, are particularly suitable for extinguishment with gas. The ventilation could have been stopped by closing the coal hole and the door between the two rooms.

The results of Test VIII indicate fairly conclusively that the concentrations of gas required for comparable fire conditions are independent of the size of the room. Thus, extinguishment of fires in larger spaces can be regarded as presenting no added problem other than the larger amount of gas required.

That the gas will penetrate closed metal shelving and ordinary metal filing cabinets and extinguish fires in their contents is illustrated in Tests Nos. II and IX. Salvage of records is much easier than if wet with water.

The full scope of application of this method of extinguishment can be determined only by such experience as will enable a balance to be made between the cost of extinguishment and the saving effected by the more rapid extinguishment and less damage to construction and contents than would obtain with the exclusive use of water.

ACKNOWLEDGMENT: Gas and equipments were supplied by: American-La France and Foamite Industries, Inc, C-O-Two Fire Equipment Company, Walter Kidde and Company, Inc., Cardox Corporation. Assistance and coöperation in connection with the tests were given by the District of Columbia Fire and Police Departments. The National Bureau of Standards, Dr. Lyman J. Briggs, Director, made available much of the facilities and personnel required, and Commissioner of Public Buildings, Mr. W. E. Reynolds, made the larger building available for the tests.

Lorain, Ohio, Scrap Metal Fire.

A fire in a large pile of scrap iron and steel borings and turnings stored on an ore dock of the Baltimore and Ohio Railroad at Lorain, Ohio, presented an unusual problem in fire fighting last October. The material was more or less oily, but no evidence of spontaneous heating had been noted during two years of previous storage at Saginaw, Michigan.

On October 8, 2400 tons of the turnings were unloaded from a steamship and placed on the dock, which was operated by the Toledo, Lorain and Fairport Dock Company. It is reported by the fire department that at the time of unloading there was some evidence of heating, but apparently this heating was not considered important at the time. The turnings were placed in a pile about 30 ft. high, resting on the concrete floor of the dock between 8 ft. concrete retaining walls on two sides.

Some of the metal was removed by an overhead traveling crane, leaving 1322 tons of the original cargo on the dock on October 18, when the dock superintendent reported evidence of heating.

The fire department was called on the evening of October 19 to extinguish a small fire in a pile of old railroad ties a few hundred feet from the dock. At this time the fire chief noticed that the pile of steel turnings was smoking. On the evening of October 20 the fire department was notified of the fire by dock policemen, but was requested to do nothing until called again.

Plans for Fire Fighting.

The insurance companies concerned were then notified and the proper method of handling this fire was discussed. A number of different agencies were consulted and various schemes were proposed for extinguishing the fire. One scheme suggested was to cover the pile with clay and pour carbon tetrachloride through a hole in the top. This plan was rejected because it was costly and would tend to impair the value of the stock. Another suggested scheme that was rejected consisted in making a hole in the top of the pile, putting lime in it, and then throwing water on the lime. This was supposed to produce steam to smother the fire.

It is a good thing that neither of these methods was tried out. Either would have been likely to result in serious injury. Violent reactions might have been expected in each case when the extinguishing agent came in contact with the hot metal.

This report is based on information from the Ohio Inspection Bureau (Member N.F.P.A.), the Lorain Fire Department, and data from other sources.

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General view of the burning pile of iron and steel turnings at Lorain, Ohio. The carbon dioxide tank truck may be seen in the right background.

Practically every one whose advice was asked cautioned against the use of water in this fire. They were probably influenced by reports of previous experience with the use of water on fires in piles of scrap metal, particularly aluminum. Observers may have had in mind the demonstration of this fact by a fire in 1933 in a plant at Cuyahoga Heights not far from Lorain. A pile of borings of aluminum took fire. The fire department turned a hose stream on the middle of the pile. The result was a violent explosion.

When water from a 2½-in. hose line was used experimentally on this fire, a reaction took place in the nature of an explosion, which bore out the advice not to use water. One and one-half-inch hose was then used around the base of the pile, which caused a less violent reaction.

As a practical matter, iron borings are relatively less dangerous than aluminum. Experience in fires in iron and steel turnings and borings has shown that water may often be used successfully. Most such fires which are on record have occurred in barrels or other small quantities of borings and turnings and have been extinguished successfully by the use of small hose streams or water-solution extinguishers. A fire under conditions comparable to the present case was reported in Detroit in June, 1920, when a large pile of iron and steel borings and turnings took fire in a railroad yard. It burned for a week or more. That fire was controlled by the use of hose streams operated from a safe distance and, as in the present case, was finally extinguished by overhauling the pile, using a power shovel.

The Lorain Fire Department was satisfied that it could handle this fire with water if the material was moved in small quantities. The problem was how to pick up small quantities of the material without serious heat damage to the conveyor.

Carbon Dioxide.

Among those whose advice was sought regarding the fire was A. H. Nuckolls, Chemical Engineer, Underwriters' Laboratories, Inc., Chicago, Chairman of the N.F.P.A. Committee on Hazardous Chemicals and Explosives. Mr. Nuckolls suggested carbon dioxide. His plan was put into effect, with the use of carbon dioxide in large quantity, supplied by tank trucks.

At about noon on October 30, plans for combating the fire were agreed upon and put into execution. The dock furnished a clam-shell bucket unloader and a tractor snow plow. The Lorain Fire Department furnished two shifts of six men each. The technique developed and used was to scoop into the burning pile with a clam-shell digger, pick up about three tons of hot turnings, and deposit the load on the dock away from the large pile. Carbon dioxide was sprayed almost continuously on the bucket to prevent possible damage by heat.

When the clam-shell took a bite at the pile, the hot metal flared up violently on reaching the air. This flare endangered the crane operator. The owners of the crane feared the clam-shell and crane would be damaged if used

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The burning pile flared up every time the hot metal was exposed by a "bite" of the clam-shell bucket.

to overhaul the whole pile. The carbon dioxide provided the cooling effect needed to protect the crane operator and equipment.

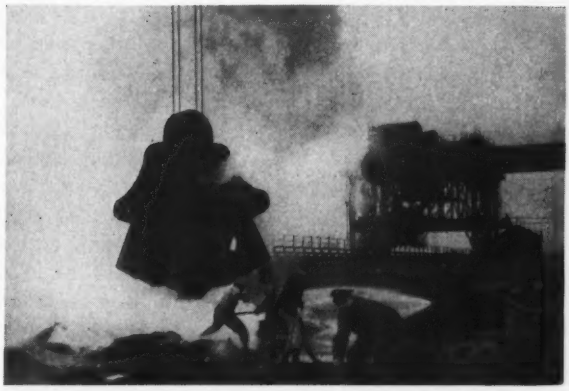
As soon as the clam-shell had dumped its contents on the dock, the snow plow scattered the hot metal, which was then cooled down with carbon dioxide and water. Water was supplied through a fog nozzle from a hydrant located some 800 feet distant. Both hydrant connections were siamesed with a 2½-inch hose line. A pumper was not used.

Final Extinguishment.

The actual extinguishment was not by water or carbon dioxide, but by the process of overhauling the burning pile. Each load of the clam-shell bucket brought a relatively small amount of the burning material out in the open, where the temperature dropped to below the red heat, after which it could be further cooled by water with safety.

The process described was continued until the evening of November 1, when the turnings, well scattered, had practically ceased burning. Water was used all the following day and the fire was finally declared extinguished after having been fought for over fifty hours with five tons of carbon dioxide and an estimated 600,000 gallons of water.

It is reported that the fire was not spectacular. Although a large volume of smoke was emitted, flames burst forth only when the mass was disturbed, as by the digger. A pyrometer thrust about one foot into the burning pile recorded a temperature of 1700° F. The steel, therefore, did not reach the fusion point, and this conclusion was confirmed by the absence of slag after the fire was extinguished.



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The turnings were cooled with carbon dioxide and water spray after they had been spread out.

The market value of the pile of oily turnings was approximately $24,000 on the day of the fire. If the fire had been allowed to burn itself out, there would probably have been little if any salvage. As it was, probably two-thirds of the pile was saved.

Chemistry of the Fire.

Mr. Nuckolls explains the fire fighting problem involved as follows:

"Water reacts readily with iron, particularly when finely divided, at red heat or higher temperatures, with the formation of iron oxide and hydrogen. The hydrogen may then combine with explosive violence with the oxygen of the surrounding air.

"Further, when water is applied to red-hot iron, it is suddenly converted into vapor or steam, which occupies a much larger volume than the water in the liquid phase. In addition, the steam is expanded by the high temperature, according to the well-known gas laws.

"There are, therefore, two sources of explosions when water is applied to red-hot iron: first, the chemical reaction forming hydrogen gas; second, the conversion of water into steam, which is then expanded by heat. The hydrogen reaction appears to be the more dangerous, particularly where the iron is comparatively finely divided, thus presenting a large area for the reactions mentioned; and the combination of the two processes may constitute a serious danger in practical work.

"Where the amount of iron involved in the fire is comparatively small, it may be practicable to apply a large enough volume of water to minimize the hazards mentioned above, but in the case of large piles of red-hot steel turnings such procedure is dangerous. Even at high rates of application of water

(within practical fire department limits) to the surface of a large pile, the water reacts with the red-hot iron below the surface, thus producing internal pressure (from expanded steam), and also hydrogen flames and explosions as the surrounding air is contacted.

"Scooping into the burning piles with mechanical diggers during the application of water obviously does not remove this danger, as considerable masses of hot metal remain to react with the water.

"It is true that a comparatively high temperature (red heat and above) is necessary to obtain a dangerously sudden conversion of water into steam and a comparatively rapid reaction producing hydrogen, and therefore water can be comparatively safely applied to the metal after cooling it below a red heat.

"The application of carbon dioxide gas and snow functions to cool the hot metal, at the same time retarding the oxidation process, with the result that the portion of the metal exposed cools rapidly by radiation, conduction, etc. Digging into the pile without at the same time using means of retarding oxidation simply presents more hot metal surface to the oxygen of the air, thus promoting the oxidation of the iron and the burning of the distillation products of the oil, with the net result that the temperature of the mass may be even higher than before."

Grand Rapids Spring Factory Fire.

One of the largest industrial fire losses of the year 1939 occurred at Grand Rapids, Michigan, on October 30, when the large sprinklered plant of the McInerney Spring and Wire Company was destroyed with a loss estimated at more than $600,000. The plant was engaged in the manufacture of custom-built automobile seat and cushion springs. Fire starting in a japan bake oven spread quickly to the adjacent dip tank and drainboard. Automatic foam protection and automatic drains at the dip tank apparently failed to function and a large canopy over the tank, drainboard, and stock prevented sprinkler water from reaching the fire. The tank was located in a room of large area and more sprinkler heads opened than existing water supplies could effectively serve. Conveyor belts piercing fire walls further contributed to the spread of the fire throughout the plant.

Description of Property.

The plant consisted of a compact group of one and three-story brick buildings with part basement, having plank on timber floors and roofs. Building No. 1 was cut off by the fire walls from the other buildings of the plant and door openings in the fire walls were equipped with automatic fire doors. However, several openings were obstructed by conveyors, so that the fire doors were rendered useless. The conveyor openings through floors were protected only by heat bank curtains.

Dipping operations on the first floor of Building No. 3 were not cut off from the remainder of the floor area, which was about 65 x 285 ft. Spring assemblies on a monorail conveyor were dipped in a 6 x 23 ft. tank containing at the time of the fire some 1900 gallons of japan dip thinned with a flammable solvent. The tank set flush with the floor at the south side of Building No. 3, near where they were baked in a gas-fired, box-type oven. At the time of the fire the plant was operating in two eight-hour shifts. It is reported to have been rather congested.

The drainboard and dip tank were protected by a fixed pipe foam system supplied by two 40-gallon tanks controlled by a rate-of-rise heat actuated release, but there was no automatic protection for the freshly dipped stock. An automatic release also operated a quick-opening valve controlling an emergency drain arranged to drain its contents to tanks located in a low unused space below the floor. These protective features were tested satisfactorily before an insurance engineer in September. Both the dip tank and 6 x 24 ft. drainboard were covered with a canopy, under which a quantity of freshly dipped springs were hung for drainage.

Front view of Building No. 1 at the McInerney Spring and Wire Company plant comparatively early in the long battle against the flames. Conveyor openings in the fire wall allowed the fire to readily spread to this building from the No. 3 building in the rear.

The plant was equipped with a modern wet pipe sprinkler system supplied by a 6-inch connection from an 8-inch public low service main and an 8-inch private main from a 12-inch public high service main. There was also a fire department connection to the sprinkler system. There were no sprinklers under the canopy.

Start of the Fire.

The cause of the fire has been considered the overloading or careless loading of freshly dipped spring assemblies, resulting in contact of fresh japan with heated surfaces of oven ducts or ignition of japan vapors. The oven ventilation was said to be adequate for normal operations, with temperature controls installed, and the gas supply, ventilation and safety pilot interlocked.

Under normal operation at set periods of time, baked springs passed out of the oven and new freshly dipped springs moved in. However, to speed up production the period of time in the oven was reduced and the baking process was speeded up. According to the report of the Grand Rapids Fire Department the oven had backfired several times in the period immediately prior to the fire and employees pushed the oven door shut with a pole kept for that purpose.

Information obtained by the fire department indicates that the fire was observed for a period variously reported at twenty-five minutes to one hour before the arrival of the fire department, though other sources of information indicate a shorter time before the fire department was called. Flames were

seen shooting in the air through a stack at the point of the fire and dense smoke was coming from every window for some minutes before the fire department came. It is said that women employees were notified of the fire and asked to be ready to leave the building, but it was believed that the fire would be put out without notifying the fire department. Later they were ordered out and instructed to stand by. Knowing that it would be some time before they could reenter, one group went to lunch and when they returned, the fire department had arrived.

The fire department obtained further information to the effect that plant employees were twice successful in subduing the fire with plant equipment, but that each time it broke out anew and involved the entire area.

The fire started some time before 3 P.M. when one of the dull explosions or puffs burst open the doors of the box oven, releasing a wave of heated air and an outrush of flames which ignited the spring assemblies hanging on the monorail in front of the oven. From there the flames quickly spread over the freshly dipped stock and to the drainboard and adjacent dip tank. Statements of two plant employees who attacked the fire with hand chemicals prior to the arrival of the fire department are to the effect that there was no foam delivered to the surface of the burning tank. One of these men stated further that the liquid level of the dip tank did not drop. There is no report of any attempt to operate the foam system or drain valve manually. Employees also stated that at the first stage of the fire sprinklers were operating with a full flow of water which drenched the employees attempting to extinguish the fire.

As the dip tank and drainboard were curbed and canopied, no water was flowing into the tank, so that sprinklers had no effect upon the dip tank fire or upon the stock under the canopy. It is reported, however, that the dip tank was operated partially filled with water, with less than 2 ft. depth of japan to immerse the springs passing through the dip on the conveyor. The captain of the first fire company to arrive entered the fire area at 3:08 P.M. and stated that the dip tank was then full and was burning fiercely over its entire surface. When the first chief officer arrived at the fire about eight minutes later, many sprinklers were in operation, each receiving a scant quantity of water, which was dribbling to the floor.

Fire Fighting Operations.

The first public alarm was given at 3:03 P.M., when a telephone call was made from the plant. Fire department headquarters sent a pumper and a service ladder truck on a still alarm from a fire station about a quarter of a mile away. The operator then sent out an alarm from the nearest box. At 3:04 P.M. another alarm was received from a private alarm box in the plant, but the headquarters operator advised that he had already sent equipment. Upon arrival of the first pumper, the captain immediately pulled a city box at 3:08 P.M., but this box had already been transmitted.

For a time it appeared that the fire department had the blaze under control, having surrounded the fire area from three sides with hose streams, including a powerful siamesed stream near the center of the fire. One of these streams was placed to cover the firewall openings. The fire department officers, knowing that the first alarm pumpers were operating on low pressure mains nearest the fire, ordered additional alarm pumpers to operate from high pressure mains to the north of the plant, both in supplying streams at that side of the fire and to relay additional water to the pumpers on the low pressure mains. The city water department, realizing that there was a large fire and knowing the water supply conditions, at about 5 P.M. sent a crew to open various valves between the high service and low service mains in the vicinity. Due to heavy traffic, these valves could not be reached until about 6 P.M., when the pumpers on low service mains received an improved supply.

The fire department appears to have fought the fire in an aggressive manner, working from the inside on all three floors of Building No. 3, and attempting to cover all horizontal and vertical openings. Ladder companies ventilated wherever possible at the roof and at windows. At times when various fire companies were driven from their positions by the intense heat, heavy siamesed streams were operated from the outside until it was possible to reoccupy their assigned positions. Some of the companies used gas masks while working inside.

Explosions of flammable liquids made fire fighting operations difficult. This photograph was taken late in the fire at a point close to where the fire started.

Interior of Building No. 3 at the McInerney Spring and Wire Company plant in Grand Rapids following the fire of October 30, 1939. Fire starting in a japan oven on the first floor of this building spread to a dip tank where automatic foam protection failed to function.

About 4:15 P.M. a minor explosion, described by the fire department as a swirl of flame and a back draft, flashed through the room, driving the firemen outside of the building with several very narrow escapes in which one hose line was lost. A short time later a major explosion occurred, throwing firemen to the ground and injuring several severely. This explosion apparently occurred when a large tank of thinner near the north wall of Building No. 3 let go. The blast lifted the roof and shook the walls. However, the roof dropped back in place and held the walls for a short time, when sections of the wall began to fall, due to the breaking of the bonding in the brickwork.

The fire then spread to all parts of the plant, due to lack of effective fire cut-offs at fire walls and floors where conveyors passed through openings and prevented fire doors from closing or where unprotected except for draft curtains.

Following the explosion a general alarm was sounded, bringing the remainder of the fire department. The off shift had previously been recalled to duty and gave valuable assistance in strengthening companies at the fire and in manning reserve apparatus. With the exception of protecting the office and a warehouse, the firemen were forced to conduct their operations from the outside following the explosion. A large stock of combustible materials, such as japan thinner and burlap (loose and in bales), contributed to the rapid spread

of the fire. A total of thirteen pumpers supplied hose streams, including a three-way turret nozzle and two heavy streams from aerial ladder pipes. A total of about twenty-five streams were used. The fire was brought under control about 8 P.M., but was not completely extinguished until the following day.

It is possible that the automatic drain valve on the dip tank may have ultimately operated and that the first explosion at 4:15 P.M. was the result of dumping the remaining contents of the dip tank into the unsprinklered space under the first floor. There is also evidence that in the early stages of the fire, considerable enamel was spilled and spread over the floor by the overflowing of the dip tank by hose streams. In the later stages of the fire numerous drums of flammable liquids exploded, making fire fighting difficult, although the fire department was able to remove a number of such drums before they could become involved.

A pumper was connected to the fire department sprinkler connection about 3:40 P.M., but by this time the fire was apparently beyond the control of sprinklers, and the piping may have been broken. These lines were kept in operation until it was certain that the sprinklers were no longer effective. The sprinkler valves were said to have been closed about 9 P.M.

The four main buildings of the plant were almost completely destroyed, together with their contents. There was some damage to the monitor of the boiler house and to part of the roof of a one-story frame warehouse at the rear of the plant. Property damage to buildings and contents has been estimated at $606,000. In addition there was some insured use and occupancy loss.

Tank Truck Fire, Sharpsburg, Pa.

By Allegheny Division, Middle Department Rating Association, (Member N.F.P.A.).

A fire, which destroyed a gasoline semi-trailer tank truck, dwellings and several automobiles and damaged a dozen other buildings, occurred at Sharpsburg, Pa., on the morning of August 31, 1939, when a breakdown of the truck tractor hauling the semi-trailer tank broke off a two-inch discharge valve, allowing gasoline to escape into the street. One of the most threatening aspects of the blaze occurred when flames severed power lines supplying water works pumps. Fortunately an adequate reserve water supply was quickly made available, allowing firemen from five companies to control the fire before a more serious conflagration developed.

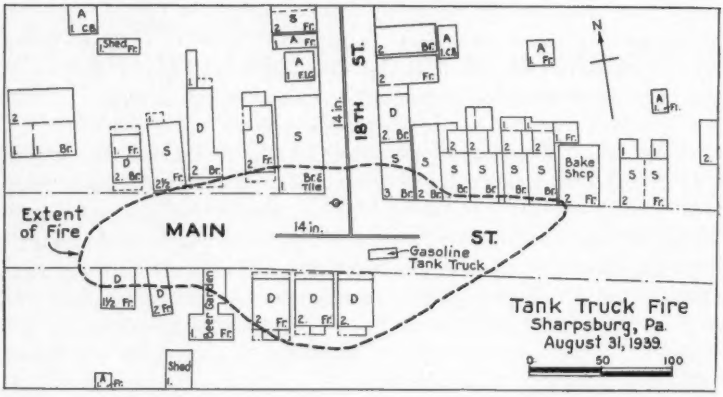
Story of the Fire.

Shortly after 9:30 A.M. on August 31, 1939, an auto truck tractor hauling 3000 gallons of gasoline in a semi-trailer tank stopped at a traffic light on Main Street in the outskirts of Sharpsburg, Pa., an industrial town on the Allegheny River five miles north of Pittsburgh. As the light changed to green and the truck started forward, the right rear wheel of the tractor came off, letting the rear end of the truck and the front of the semi-trailer down. In some manner, whether struck by the wheel or part of the tank's pony wheel rod which was broken, the front two-inch valve of a series of four discharge valves located under the semi-trailer tank was sheared off. The resulting flow of gasoline from the outlet ignited almost immediately, either from a static spark or the truck exhaust. The driver, realizing the seriousness of the situation, abandoned the truck without attempting to use the hand chemical extinguisher.

The burning gasoline poured into the street and ran down the gutters. The porches on two frame dwellings on the south side of Main Street about ten feet from the tank truck were quickly ignited and when the first fire apparatus arrived both dwellings were well involved. Hose lines were laid from near-by hydrants and an effort was made to extinguish the fire at the tank and dwellings, but the tank soon became heated to a point where it resembled a huge blow torch, with burning vapors discharging from the tank manhole vents high into the air. At this time the fire began to involve buildings on the other side of the street.

Calls for aid were sent to surrounding communities. The volunteer fire departments of Aspinwall, Pleasant Valley, and Etna each responded with a pumper and the City of Pittsburgh sent two pumpers.

The rapid spread of the fire and the falling of high voltage power and trolley lines forced firemen to fall back, abandoning several lines of hose. The



falling wires caused short circuits, igniting the main switchboard at the town's power plant. This necessitated the shutting off of all power and resulted in shutting off the town's water supply, as all pumps are electrically driven by power controlled through the main switchboard. An emergency power supply from Pittsburgh was also disrupted by the fire. As there is no elevated storage in the Sharpsburg distribution system, this left the town temporarily without water.

However, the superintendent of the water plant hurried to a valve five blocks away, opening a sixteen-inch connection from a sixty-inch main from a Pittsburgh pumping station. Probably a period of five minutes elapsed between the time when the water was shut off and the restoration of the emergency supply. During this time firemen were laying hose lines from hydrants at a safer distance.

The absence of water for this short period was fortunately not a serious factor, as the hose lines that had been in service up to that time had been abandoned in the retreat. About the time additional lines were ready, water was again available.

It was soon evident that the first two dwellings involved and another adjacent to the west were doomed. Efforts were concentrated in preventing the spread of the fire. It was decided to let the fire in the tank burn out, as there were no means other than water with which to fight the fire.

In addition to the three dwellings and several automobiles destroyed, on the south side of the street a beer garden and two other dwellings had fronts burned out and roofs damaged. Across the street a three-story brick saloon and dwelling was badly damaged and a one-story brick grocery store had its front and part of the roof burned. Half a dozen other stores and dwellings on the north side of the street suffered more or less damage to their fronts.

The burning of a semi-trailer tank truck containing 3000 gallons of gasoline on Main Street, Sharpsburg, Pa., in the morning of August 31, 1939, resulted in the complete destruction of three dwellings enveloped in the flames at the left of the picture. A dozen other buildings were damaged. Flames also severed power lines supplying waterworks pumps, temporarily cutting off the public water supply. The fire is attributed to the lack of emergency valves inside the truck tank, as specified in the N.F.P.A. Tank Truck Ordinance.

About twenty streams were used to control the fire. The tank truck fire burned for forty to fifty minutes, but the control of the building fires required about three and one-half hours.

Loss and Conclusions.

The loss was approximately $30,000. The loss to the Borough in power lines, poles, wires and traffic signal system was about $2700. Fortunately there was no loss of life or injuries, although occupants of the first dwellings ignited barely escaped. It would be difficult to say what the loss of life or property damage might have been had the accident occurred in a congested part of the town.

Investigation after the fire revealed that the 3000 gallon semi-trailer was divided into four 750-gallon compartments. The tank was of welded seam construction. The load was being taken from a refinery at Freedom, Pa., to New Kensington, Pa.

Laboratory tests were conducted on the tractor axle housing to determine why the wheel came off, and it was found that at some time a bearing had apparently been frozen in the housing and had been cut out by an acetylene torch, leaving a weakened area in the housing, which let go, breaking the axle and causing the wheel to come off.

The seriousness of a situation where the power supply for the pumping station can be disrupted by fire, especially where there is no elevated storage

in the water system, is obvious, but in this case it is minimized by the fact that the emergency supply was superior to the normal supply. Also such disruption would be hardly conceivable in any area beyond streets traversed by the main transmission lines.

It is also worth noting that if the tank truck had been equipped with emergency discharge valves inside of the shell of the tank in the compartment outlets and kept closed except during delivery operations, as specified in the N.F.P.A. Tank Truck Ordinance, this fire in all probability would have been averted.

Packing Plant Explosion, Ottumwa, Iowa.

Report by Iowa Insurance Service Bureau,
(Member N.F.P.A.).

An explosion and fire following a break in a large ammonia pipe line in an engine room of the John Morrell and Co. meat packing plant at Ottumwa, Iowa, caused a partial collapse of the building, resulting in heavy damage to the building and equipment on September 30, 1939. Considering the location of the explosion it is fortunate that losses to stock dependent upon refrigeration, were comparatively light.

The building in which the explosion occurred is a one-story engine room structure situated in the northeast section of the plant. It had brick walls, reinforced concrete floor on concrete supports, concrete and tile roof on exposed steel trusses in one-half of the roof and on exposed steel beams in the other half. A large frame louvered roof structure, 50 by 60 feet, housed heavy auxiliary refrigeration equipment, principally condensers. Five of the condensers were of tubular type, weighing ten tons each. The building housed three steam driven ammonia compressors, having a total capacity of 1275 tons; a large steam turbine electric generator, switchboard and auxiliary power plant machinery.

Story of the Explosion.

Most of the plant departments had shut down at noon Saturday, the day of the fire. Shortly before 1 P.M. the 500-ton ammonia compressor was "bumping" a little. This was said to have been due to liquid in the suction line. The oiler on duty was shutting the throttle on the machine when there was a sudden release of ammonia gas which filled the engine room. Although what had broken could not be determined at the time, it was later established that a four-inch elbow in the ammonia discharge line about ten feet below the ceiling had broken, allowing ammonia gas to discharge vertically against the ceiling.

The oiler succeeded in escaping from the building. A plant watchman in another building, sixty feet distant, smelled ammonia fumes and looking from

a window saw the white vapor pouring from open windows. He turned in an alarm, which was received by the fire department at 1:15 P.M. They responded with three pumpers and an aerial truck. During the short time between the sounding of the alarm and the arrival of the fire department many things happened. The plant firemen were driven from the communicating boiler room by the strong ammonia fumes. Two other plant employees wearing gas masks had started to enter the engine room to shut down the generator. As they entered a doorway an explosion occurred, forcing these men out of the doorway. Fortunately, they were not injured. No windows were blown out and no part of the building was wrecked by the explosion.

The cause of the explosion was the mixture of air and ammonia that had apparently reached the lower limits of an explosive mixture and ignited no doubt from a spark in the electric generating equipment in the engine room. Following the explosion the escaping ammonia gas continued to burn. The blaze resembled a torch shooting an orange colored flame against the ceiling, mushrooming against one of the large exposed roof trusses. Within ten to fifteen minutes the heat from this flame weakened the roof supports and half of the roof collapsed, bringing the tons of condenser cooling coils and equipment in the roof house down on the ammonia compressors, creating a tangled mass of wreckage. The south wall of the engine room fell outward. Other walls and the north part of the roof remained in place, although the exposed steel beams began to buckle. When the roof collapsed, the ammonia fire was extinguished, possibly by concussion. The framework of the roof house was aflame after the collapse, but was quickly extinguished by hose streams.

Result of the Explosion and Fire.

The entire plant was without power, light, steam and refrigeration. The fire department was hampered in combating the situation by ammonia fumes. When they arrived shortly after the explosion, the automatic steam fire pump was inoperative due to loss of steam supply. The only water immediately available for hose streams was from a 75,000-gallon gravity tank. The fire department pumped into the plant underground system, taking suction from a nearby reservoir and discharging into a hydrant. Water was also pumped from city hydrants to private hydrants.

The fire department left the premises at 3:20 P.M. and work was started in clearing the wreckage and providing temporary means of restoring power, steam and refrigeration to important departments of the plant. The utility company had power restored Saturday evening.

The main twelve-inch steam line to other sections of the plant, including the fire pump and ammonia compressors in the other engine room, passed through the engine room involved and was damaged when the roof collapsed. This steam line was placed in service the following morning, but only fifty

pounds steam pressure could be maintained instead of the normal 165 pounds pressure because the boiler feed pumps in the engine room were out of action and the only source of boiler feed water was from city pressure. A reserve boiler feed pump was repaired and placed in operation by Sunday afternoon, and thirty-two hours after the fire the two ammonia compressors in the other engine room were placed in service with sufficient capacity for emergency operation. Repairs and replacements in the damaged engine room required the better part of a month.

Loss and Conclusions.

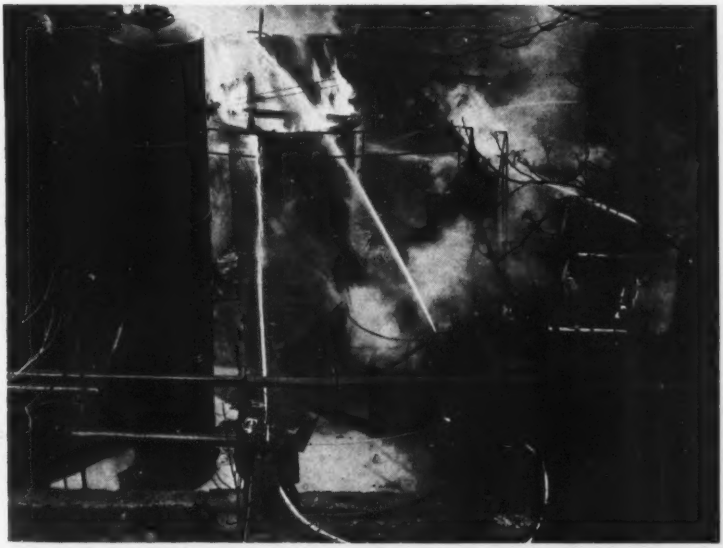
No definite information has been obtained regarding the extent of the loss. However, one plant official stated he was hopeful the loss would not exceed $100,000. There was no insurance coverage on the building or contents, presumably in view of the incombustible construction and occupancy. Considering the vital location of the occurrence, other possible losses throughout the plant were comparatively small; the time of the accident was a contributing factor in this respect. About one hundred hogs that had to remain on the sticking rail and scalding tank were a loss. There was sufficient cold brine in the brine tanks and enough latent refrigeration in the cold storage areas to save perishable stock.

Explosions and fires involving ammonia gas are comparatively rare, yet the potential danger is significant. In packing plants where the demand for large refrigerating capacities is essential, it appears advisable to have such units in at least two well-separated locations and in buildings detached from the power plant. In this instance the forethought in having refrigeration equipment divided into two well-detached locations had decidedly gratifying results. The installation of vapor-proof lighting equipment and effective separation of electrical generating equipment should prove an effective safety measure in ammonia compressor rooms where large quantities of ammonia gas are likely to be liberated.

Soap Factory Fire, Philadelphia, Pa.

The hazards of manufacturing processes involving the use of flammable materials, even when the plant management is actively alert to the problems, were forcibly demonstrated on December 8, 1939, when an explosion and fire occurred at the Philadelphia soap manufacturing plant of Fels & Co. It is reported that the fire started in the compounding room when a rosin still exploded from an undetermined cause. The explosion killed one employee and burned two or three others slightly. Because both rosin and naphtha were involved, the fire spread with great rapidity and soon enveloped the entire building, which was a two-story brick-joist structure with a plank roof.

Fanned by a forty-five mile wind, the fire threatened to spread to near-by buildings, burning off the roof covering of large areas and starting many incipient fires. The intense heat cracked all the wired glass windows in the exposed walls of these buildings, but the fire did not gain entrance. Seven sprinklers operated on the third floor of one exposed building and seventeen heads on the fourth floor of another operated or were knocked off. These aided materially in cooling the exposed walls and windows.



Acme.

Firemen are here shown attacking with hose streams the fire in the exploded rosin still.

International: Phila. Inquirer.

Aerial view of the spectacular four-alarm fire of December 8, 1939, which followed the explosion of a rosin still at the Philadelphia plant of Fels & Co., soap manufacturers.

The fire department was promptly notified and while awaiting its arrival, employees fought ineffectively with hand extinguishers, the fire being beyond the control of first-aid equipment. The company's fire brigade laid four hose lines, which were supplemented by twenty-four more streams provided by the municipal fire department and a county volunteer department. The water supply was adequate at all times. The company's hydrant system was fed by a 100,000-gallon standpipe, a 50,000-gallon gravity tank and also was connected to two four-inch municipal water mains and one six-inch private water company main. The company's steam fire pump was of major assistance in supplying hose streams throughout the fire and ran continuously, maintaining pressure of not less than sixty pounds per square inch.

The building where the fire originated was not equipped with sprinklers or any other automatic fire extinguishing system, and the fire resulted in its complete destruction with a loss of approximately $175,000.

Acme.

Dense clouds of smoke from burning rosin and naphtha spread over West Philadelphia as the flames threatened near-by buildings.

Fires in Which There Was Loss of Life.

Fourth Quarter, 1939.

Since the publication of the October, 1939, QUARTERLY, the N.F.P.A. Department of Fire Record has received reports of one hundred and twenty-nine fires in the United States and Canada in which there was loss of life. Two hundred and one persons died as a result of these fires. During this period the following fires were reported which resulted in the death of five or more persons each.

NOVEMBER 4, 1939, MARSHALL, TEX. Three men and two women were burned to death after a heavily loaded gasoline tank truck collided with an automobile, and a third woman was fatally injured when thrown from the automobile. It is reported that one of the five compartments of the tank truck burst open from the force of the impact and flaming gasoline enveloped the two vehicles. (H-43470.)

NOVEMBER 5, 1939, BEAVER DAM TOWNSHIP, N. C. A farmer and four small children were trapped and burned to death in a fire which destroyed their rural home. (L-5830.)

DECEMBER 18, 1939, NEAR GRACEWOOD, GA. Five youths were burned to death when fire swept a reconditioned barn used as a dormitory at the Georgia State School for Feeble-Minded Children. Two others were critically injured. The cause of the fire is unknown, but is reported to have started in a linen room on the first floor of the building. There were twenty-five boys housed in the dormitory, several of whom escaped by sliding down outside pipes. (H-43469.)

Foreign Fires.

Several fires involving large losses of life have been reported during this quarter from points outside the United States and Canada. These fires are not included in the tables, but summaries of the most important are given below.

SEPTEMBER 24, 1939, BOCHUM-HORDEL, GERMANY. Fire, following an explosion in a mine, killed seventeen miners and seriously injured fourteen others. It is also reported that eight miners are unaccounted for. Further details of this tragedy are lacking. (L-5829.)

OCTOBER 1, 1939, PALAU, MEXICO. Sixty-nine miners were killed and two injured in a coal mine explosion. An accumulation of gas was given as the cause of the blast. (L-5824.)

OCTOBER 8, 1939, ST. ETIENNE, FRANCE. Thirty-seven dead and more than thirty injured was the toll of a coal mine explosion. Investigators attributed the blast to a short circuit which ignited accumulated gas. (L-5825.)

OCTOBER 22, 1939, TOLOSA, MEXICO. Approximately forty persons, including women and children, were killed when two gasoline laden railroad tank cars left the tracks at a point where workmen and their families were cooking over open fires. The tank cars took fire and the flames spread to other cars in the train. (L-5826.)

NOVEMBER 1, 1939, LA BOUVERIE, BELGIUM. Eleven persons were killed and twelve injured in a coal mine explosion. Further details are lacking. (L-5827.)

NOVEMBER 12, 1939, BREST, FRANCE. Several seamen and dock workers were killed by a tremendous explosion which took place aboard a tanker from which an oil cargo was being discharged. The exact number of dead has not been revealed. (L-5823.)

NOVEMBER 14, 1939, LA GUNILLAS, VENEZUELA. Nearly one hundred persons lost their lives when fire destroyed this pile-supported oil town on Lake Maracaibo. The fire roared through the wooden shacks which had been built out over the water as homes of the workers of the Lake Maracaibo oil fields. It is reported that the Venezuelan government will not permit the town to be rebuilt. (L-5828.)

DECEMBER 13, 1939, ZARNESTI, ROUMANIA. Sixty-two persons are reported dead and forty seriously injured as the result of an explosion in a "cellulose factory." (L-5821.)

Acme.

All that remained of the oil town of La Gunillas, Venezuela, after fire swept the pile-supported shanties during the night of November 13, 1939. Built out into Lake Maracaibo, the village was the home of some 2500 persons, nearly a hundred of whom lost their lives in this fire. The highly flammable construction of the thatch-roofed shanties and the ideal draft conditions created by the pile foundations, permitted the fire to spread with great rapidity. The hazard to life was increased by the fact that the only paths of escape were board walks, which took fire readily and were reported in some cases to have collapsed under the weight of the fleeing populace. In the background can be seen faintly some of the many oil derricks which have been constructed on the lake. Reports of survivors conflicted as to whether or not the surface scum of oil caught fire, but it was stated that within two days before the fire two serious breaks had occurred in pipe lines which had discharged large quantities of oil into the lake. (L-5828.)

Loss of Life Fires, October-December, 1939.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Men	Women	Children	Total
Airplanes	3	9	0	0	9
Airplane hangars	1	1	0	0	1
Amusement places	1	0	1	0	1
Apartments, rooming houses, tenements, hotels	10	9	2	4	15
Armory	1	1	0	0	1
Automobiles, trucks	15	11	8	2	21
Tank truck fires	3	4	4	0	8
Churches and church property	1	0	1	0	1
Dwellings—rural	25	16	14	20	50
Dwellings—urban	43	8	31	18	57
Fire fighting	5	5	0	0	5
Garages	4	3	0	1	4
Manufacturing occupancies—miscellaneous	2	1	0	0	1
Mercantile occupancies—miscellaneous	2	2	1	1	4
Mining property	1	4	0	0	4
Out of doors	7	7	1	2	10
Prisons	1	1	0	0	1
Schools	1	0	0	5	5
Yachts and boats	3	2	1	0	3
Totals	129	84	64	53	201

*This table is made up from those reports received by the Department of Fire Record between September 16, 1939, and December 20, 1939. A few of the fires included herein occurred prior to September 16, but were not reported until subsequent to that date.

Typical Loss of Life Fires.

Asphyxiation.

OCTOBER 19, 1939, BARRINGTON, R. I. A five-year-old girl was suffocated when flames swept through the home of her grandfather whom she was visiting. The child was sleeping in a second-story bedroom. While the cause of the fire was not definitely established, it is believed to have been the result of a defective flue. (L-5813.)

NOVEMBER 28, 1939, RICHMOND, VA. Four children were suffocated after seeking safety in a small room from a fire that damaged their apartment home. (L-5814.)

Children Alone in House.

OCTOBER 19, 1939, POHICK CHURCH, VA. Two small children were burned to death when fire destroyed their home. The children's father was at work and their mother was out shopping when the fire was discovered. The fire gained headway so rapidly that all rescue efforts were futile. (L-5815.)

NOVEMBER 14, 1939, CATARQUI, ONT., CANADA. Four children, the eldest aged six, were burned to death while their mother was shopping. Their father was away, serving in the Canadian military forces. The stone walls of their two-story home kept much of the smoke inside and it is believed that the children were overcome in a second-floor bedroom before the flames had reached them. (L-5816.)

Causes of Loss of Life, October-December, 1939.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Class of Fire	Men	Women	Children	Total
Airplane fires	9	0	0	9
Asphyxiation	0	1	7	8
Automobile or truck collisions and fires	12	9	1	22
Tank truck fires	4	4	0	8
Children alone in house	0	0	8	8
Clothing ignited (other than following classifications)	2	4	1	7
Bonfires, rubbish fires	2	1	2	5
Burning gasoline	2	0	0	2
Burning kerosene	1	0	0	1
Fire in fireplace	0	1	0	1
Matches	0	0	3	3
Oil lamp	0	0	1	1
Oil stove or oil heater	0	2	0	2
Smoking (see also smoking in bed)	3	2	0	5
Stove	0	2	0	2
Entering or re-entering a burning building	0	3	0	3
Escaping fires; jumped, fell or drowned	1	2	0	3
Explosions, miscellaneous	2	3	0	5
Illuminating gas	0	1	0	1
Fire fighting—firemen	4	0	0	4
Flammable liquids and vapors fires:				
Alcohol ignited	1	0	0	1
Benzine used for cleaning	1	1	1	3
Gasoline lanterns and stoves	0	1	0	1
Gasoline used for cleaning purposes	1	2	0	3
Gasoline used to start fire	1	3	3	7
Gasoline fires, not otherwise classified	4	1	1	6
Kerosene used to start a fire	1	1	0	2
Tar ignited	0	1	0	1
Mine fires and explosions	4	0	0	4
Smoking in bed	3	1	0	4
Trapped in burning building	26	18	25	69
Totals	84	64	53	201

Children Playing with Matches.

OCTOBER 5, 1939, INDEPENDENCE, MO. A small boy was burned to death as the result of playing with matches in the loft of a private garage. His playmate managed to escape down a ladder. (L-5817.)

OCTOBER 23, 1939, PROVIDENCE, R. I. A five-year-old girl was burned to death and her younger sister overcome by smoke after a mattress was set on fire as the children played with matches. It is reported that the children were alone in the house at the time. Police found burnt matches on the floor by the bed. (L-5818.)

Clothing Ignited.

SEPTEMBER 28, 1939, WEST ANDOVER, MASS. A man was fatally burned when an alcohol lamp, with which he was singeing chickens, exploded. (L-5819.)

OCTOBER 11, 1939, WELLINGTON, KANS. A woman was fatally burned when her dress caught fire from an open stove. (L-5820.)

OCTOBER 17, 1939, LEOMINSTER, MASS. An elderly man died of burns when ashes from a pipe he was smoking set fire to his clothing. (L-5811.)

International.

Ruins of the century-old four-story hotel at Winsted, Conn., where two persons were trapped and burned to death on the morning of November 9, 1939. Ten others were rescued by firemen from a third floor balcony. The building was completely destroyed. (H-43471.)

OCTOBER 24, 1939, GRAND JUNCTION, COLO. A mother gave her life in a vain attempt to save her two children from death. Their clothing became ignited as they played too near a bonfire in their back yard, and the mother's clothes also became ignited when she tried to beat out the flames. (L-5812.)

Flammable Liquid Fires.

OCTOBER 10, 1939, NEW YORK, N. Y. An explosion of highly volatile cleaning fluid fumes brought death to three persons and injuries to more than a score. The building where the explosion occurred housed an agency for a dry cleaning establishment, a motion picture theatre and a sandwich shop and was severely damaged. The blast occurred when a man, engaged in cleaning hats, struck a match to light a gas heater. The force of the blast threw a 500-pound pressing machine through the wall of the cleaning agency, cracked a theatre wall and caused the balcony to sag four inches. (H-43467.)

OCTOBER 13, 1939, COLUMBUS, OHIO. An elderly woman suffered fatal burns when paraffin wax, which was being melted on the kitchen stove, became ignited and set fire to her clothing. (L-5805.)

NOVEMBER 3, 1939, MESILLA, TEXAS. Quickening a stove fire with a kerosene-gasoline mixture brought death to a man. When the fire in a wood stove failed to kindle, the victim picked up a 5-gallon can of kerosene in which gasoline reportedly had been mixed. He threw some of the mixture into the fire and the can exploded, burning all the clothes from his body. (L-5804.)